TrangoLINK-45™

Point-to-Point Wireless

Ethernet Bridge USER

MANUAL

August, 2011
Revision 2p0r3

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Preface

This manual covers the basic configuration and installation of the TrangoLINK-45 Wireless Point to Point Broadband System, and applies to the following radio part numbers:

P5055M-19-xx	Radio unit with internal 19 dBi patch antenna array
P5055M-23-xx	Radio unit with internal 23 dBi patch antenna array
P5055M-EXT-xx	Radio unit with external RP-SMA antenna connectors

Where "xx" denotes the regulatory configuration of the unit as follows:

US: For use in the USA

IC: For use in Canada

EU: For use in the following EU member and non-member countries:
Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland (Non Members), Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Norway (Non Members), Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Netherlands, United Kingdom, Switzerland (Non Members),Bulgaria, Romania

OE: OEM model for individual certification in other countries

Each radio unit is supplied with the proper mounting hardware, a power adapter, and POE box with LED indicators. Cables must be supplied by the installer.

Two radio units are required to make a TrangoLINK-45 link. The P5055M-EXT-xx must be used in conjunction with an approved external antenna (sold separately). Instead of an internal antenna, the P5055M-EXT-xx has two reverse polarity SMA RF Connectors for the attachment of external antenna cables.

FCC Information

FCC ID: NCYP5055M

The TrangoLINK-45 System is used for point-to-point operation only.

NOTE: The P5055M-EXT-xx requires professional installation due to FCC limits on output power settings when operating in the UNII band.

This device complies with Part 15 of the FCC Rules and Regulations. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in any particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one of more of the following measures:

1) Reorient the antenna.
2) Increase the separation between the affected equipment and the unit.
3) Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to.
4) Consult the dealer and/or experienced radio/TV technician for help.

WARNING:
Intentional or unintentional changes or modifications must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty. To comply with RF exposure requirements, the following antenna installation and device operating configurations must be satisfied. The antenna for this unit must be fixed and mounted on outdoor permanent structures with a separation distance of at least two meters from all persons. Furthermore, it must not be co- located or operating in conjunction with any other antenna or transmitter.

Industry Canada Information

IC: 2945A-P5055M

Information for P5055M-EXT-IC
This device has been designed to operate with the antennas listed below, and having a maximum gain of 34 dBi. Antennas not included in this list or having a gain greater than 34 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Approved Antennas:
Radiowaves model : SPD4-5.2
Radiowaves model : SPD3-5.2
Radiowaves model : SPD2-5.2
Radiowaves model : SPD1-5.2

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

Warranty Information

Radios from Trango Systems are warranted for one year from date of purchase. Please see www.trangobroadband.com for a complete description of warranty coverage and limitations.

European Compliance Information

We, Trango Systems, Inc.,

14118 Stowe Dr Suite B
Poway, California, 92064 USA

Tel +1 858 653 3900
Fax +1 858 621 2725

Hereby declare that the product(s) listed below,

Product Name: *Wireless Ethernet point to point radio with 19 dBi antenna*
Model No: *P5055M-19-EU*

Product Name: *Wireless Ethernet point to point radio with 23 dBi antenna*
Model No: *P5055M-23-EU*

Product Name: *Wireless Ethernet point to point radio with connectors*
Model No: *P5055M-EXT-EU*

To which this declaration relates, are in conformity with the following standards and/or other normative documents:

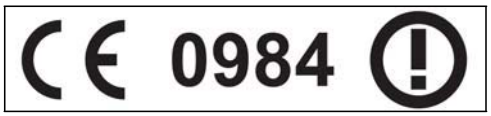
EN 301 893 v1.3.1 (2005-08)
EN 301 489-17 v1.2.1 (2002-08)
EN 60950-1/IEC 60950-1:2001 First Edition
EN 50385: 2002

We hereby declare that all essential radio test suites have been carried out and that the above named products are in conformity with all the essential requirements of Directive 1999/5/EC.

The conformity assessment procedure referred to in Article 10(5) and detailed in Annex IV of Directive 1999/5/EC has been followed with the involvement of the following Notified Body:

Compliance Certification Services (ID#0984)
47173 Benicia St.
Fremont, CA 94538 USA

The –EU models will have the following label attached to them on the back of the individual radio unit and on the packing box:



Contact Information

Corporate Headquarters	Trango Broadband Wireless, a division of Trango Systems, Inc. 14118 Stowe Dr Suite B Poway, CA 92064USA
Web Sites	www.trangobroadband.com www.trangosys.com
Sales Inquiries	email: sales@trangosys.com Telephone: 1-858-391-0010
Technical Support	email: techsupport@trangosys.com Telephone: 1-858-391-0010

Chapter 1 Overview

The TrangoLINK-45 is a point-to-point (PtP) wireless Ethernet transmission system which provides network connectivity at speeds up to 45 Mbps depending on the transmission distance and noise floor. The TrangoLINK-45 utilizes OFDM technology and is designed for use in long range backhaul and wide area data networking applications.

Users are required to simply specify one P5055M unit type as master unit (MU) and one unit as remote unit (RU) to establish a link. Each unit utilizes power-over-Ethernet (PoE) and is designed for outdoor environments. The cable entry point can accommodate both Shielded twisted pair Cat5 (STP) and unshielded twisted pair Cat5 (UTP), with the addition of conduit for tower mounting.

DFS

One of the key features of the TrangoLINK-45 is that it has Dynamic Frequency Selection (DFS) which allows it to be operated in the 5.25 to 5.35 GHz and 5.47 to 5.7 GHz frequency ranges depending upon the regulatory requirements. When operating in these frequencies ranges the MU will monitor the channel for radar transmissions and switch to a new channel automatically if radar is detected. The RU will switch to the new channel as well and the link will be automatically reconnected, typically in about 1 minute.

Each radio unit has a different threshold for detecting radar that corresponds to the radio's antenna gain. For the P5055M-19-xx models, the threshold is –46 dBm. Any radar signal arriving at the antenna on the operating channel that has an amplitude greater than –46 dBm will cause the MU and it's associated RU to switch to a randomly selected channel that is tagged as a DFS channel in the channel table. For the P5055M-23-xx units, the threshold is is –42 dBm, and for the P5055M-EXT-xx units the threshold is –37 dBm.

IMPORTANT NOTE: When operating in the DFS frequencies, the radio units will use automatic transmit power control (ATPC) to maintain the RSSI at a level of approximately –62 dBm. For very short link distances it may not be possible for the transmit power to be reduced below the Radar detection threshold and the radio may not be able to establish a reliable link. **Trango recommends that careful link budget planning be done to ensure that this condition does not exist.**

OFDM

The TrangoLINK-45 platform utilizes Orthogonal Frequency Division Duplex (OFDM) processing which offers link stability and performance in the presence of multipath interference.

Adaptive Modulation

One of the key advantages of the TrangoLINK-45 series radio platform is utilization of multiple modulation schemes including the following:

- Binary Phase Shift Keying (BPSK)
- Quadrature Phase Shift Keying (QPSK)
- 16 Quadrature Amplitude Modulation (16QAM)
- 64 Quadrature Amplitude Modulation (64QAM)

The TrangoLINK-45 system allows individual selection of the upstream and downstream modulation schemes. The modulation schemes can be adjusted manually or automatically (automatic rate shifting) for changing propagation and interference conditions. The higher order modulation schemes (64QAM) are typically deployed at reduced ranges while lower order modulation schemes (BPSK) are implemented at long distances.

ARQ

Another key advantage of the TrangoLINK-45 platform is its Automatic Repeat Request (ARQ) transmission correction scheme. The ARQ algorithm detects packet loss due to fading and interference conditions and requests the remote radio to re-transmit specific packets.

Dual Polarity Antenna

TrangoLINK-45 radios feature built-in dual polarity antenna functionality. Users may select either horizontal or vertical antenna polarity through the unit's software. The feature of selecting antenna polarity provides greater spectral flexibility and ability to mitigate interference.

Range vs. Throughput

The following table shows approximate maximum ranges (at recommended fade margins) achievable with the TrangoLINK-45 system using various antenna configurations. Longer ranges are achievable, but will result in lower fade margins. To estimate theoretical throughput and fade margin for any distance, download the link budget / fade margin calculator tool from www.trangobroadband.com .

ISM (5725 MHz to 5875 MHz) Line-of-Sight Range & Throughput

Antenna	*5 miles*	*20 miles*	*30 miles*
Integrated 23 dBi 15" Flat Panel	45 Mbps (10 db fade margin)	11 Mbps (14 db fade margin)	6 Mbps (17 db fade margin)
External 27 dBi 2' Dish	45 Mbps (18 db fade margin)	20 Mbps (18 db fade margin)	10 Mbps (20 db fade margin)
External 30 dBi 3' Dish	45 Mbps (24 db fade margin)	26 Mbps (20 db fade margin)	18 Mbps (22 db fade margin)
External 34 dBi 4' Dish	45 Mbps (30 db fade margin)	32 Mbps (20 db fade margin)	30 Mbps (15 db fade margin)

U-NII (5470 MHz to 5725 MHz & 5250 MHz to 5350 MHz) Line-of-Sight Range & Throughput

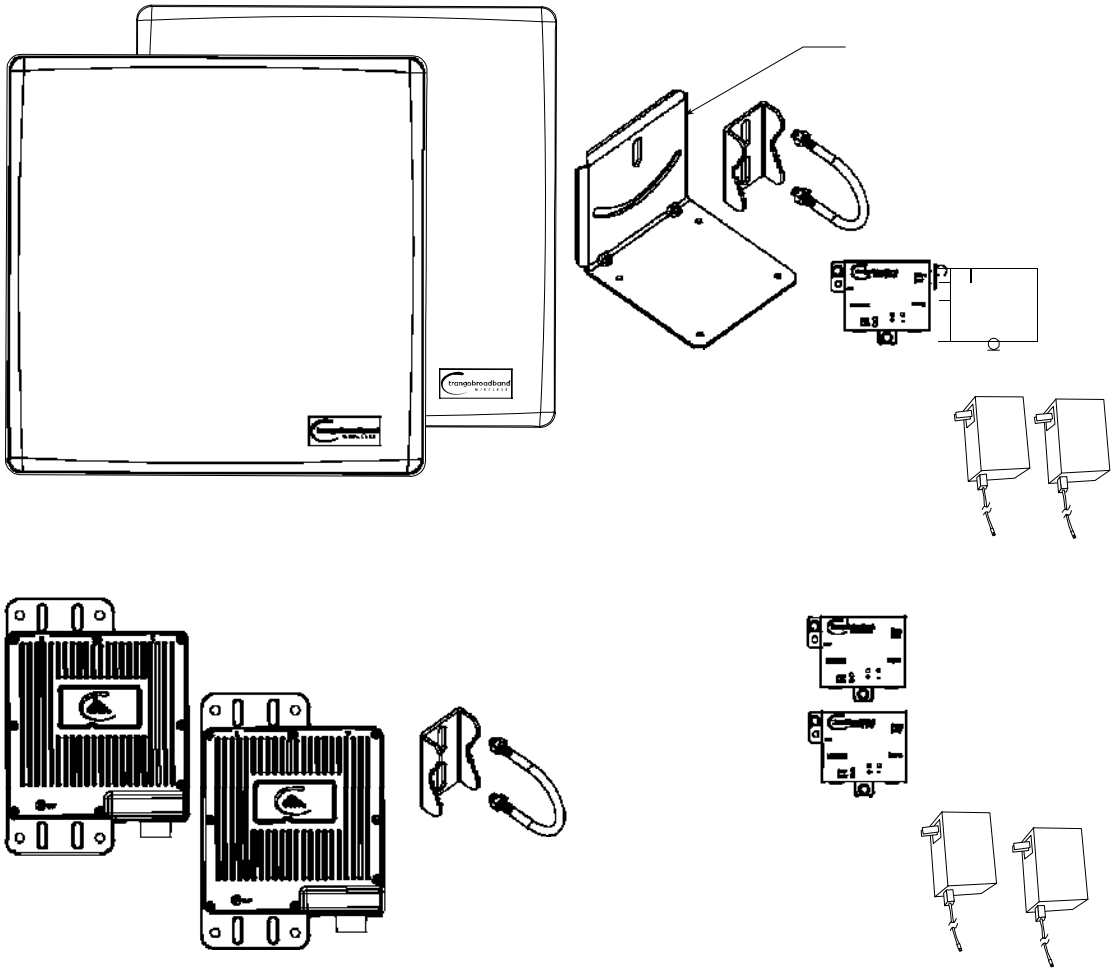
Antenna	*6 miles*	*10 miles*	*15 miles*
Integrated 23 dBi 15" Flat Panel	20 Mbps (10 db fade margin)	11Mbps (12 db fade margin)	6Mbps (9 db fade margin)
External 27 dBi 2' Dish	31 Mbps (11 db fade margin)	20 Mbps (10 db fade margin)	11Mbps (12 db fade margin)
External 30 dBi 3' Dish	31 Mbps (14 db fade margin)	20 Mbps (13 db fade margin)	16Mbps (12 db fade margin)
External 34 dBi 4' Dish	45 Mbps (10 db fade margin)	30 Mbps (13 db fade margin)	20Mbps (14 db fade margin)

System Contents

The TrangoLINK-45 system is available in two versions:

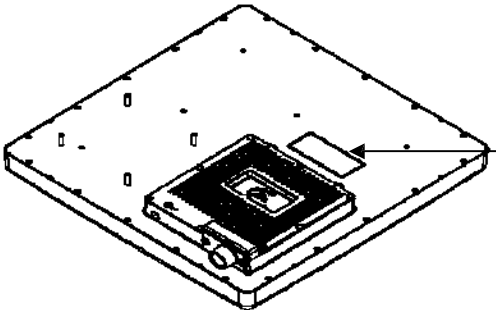
TrangoLINK-45-19-xx	- Radios with integrated 19 dBi antennas (part numbers P5055M-19-xx)
TrangoLINK-45-23-xx	- Radios with integrated 23 dBi antennas (part numbers P5055M-23-xx)
TrangoLINK-45-EXT-xx	- Connectorized radios (part numbers P5055M-EXT-xx)

Each TrangoLINK-45 kit consists of two radios, two power-over-Ethernet (PoE) injectors, two AC adapters, port covers, and mounting hardware. A dual-polarized integrated antenna is located behind the radome of the P5055M-19-xx and P5055M–23-xx units.



Location of Serial Number & MAC Address

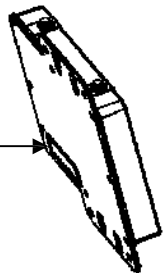
The serial number and MAC address label can be found on the back of each radio. The serial number and MAC address is also provided within the system information (sysinfo) screen.



P5055M-23-US

Trango Broadband Wireless
P5055M- 23-US Rev. A
S/N: 000001420
MAC: 00 01 DE 00 02 F2
FCC ID: NCYP5055M
Canada: 2945AP5055M
THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES: OPERATION IS SUBJECT TO THE FOLLOWING CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERANCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

Trango Broadband Wireless
P5055M- EXT-US Rev. A
S/N: 000001421
MAC: 00 01 DE 00 02 F3
FCC ID: NCYP5055M
Canada: 2945AP5055M
THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES: OPERATION IS SUBJECT TO THE FOLLOWING CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERANCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

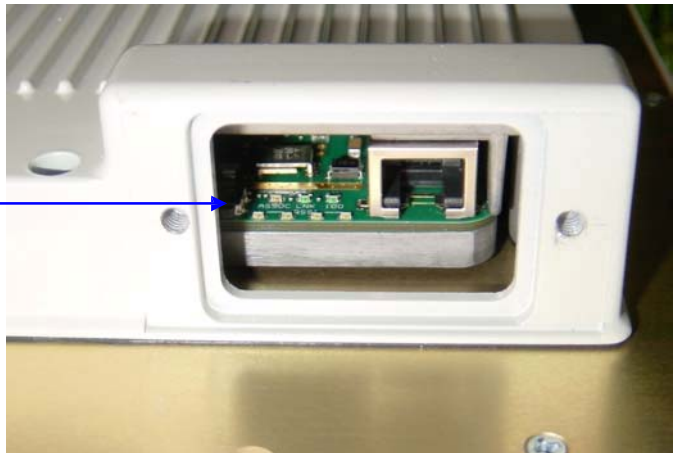


P5055M-EXT-US

Location of RJ-45/LED Port & IP Reset Button

The RJ-45 connector, diagnostic LEDs, and reset button are located at the bottom of the radio. Functionality of the LEDs is described later in this text. The IP reset button resets IP configuration and password back to factory default. The reset button does not reset any other parameters other than IP configuration and password. Typically a user would only press the reset button when the IP configuration or password in unknown. Reset button must be held down for approximately 10 seconds.

IP Reset Button



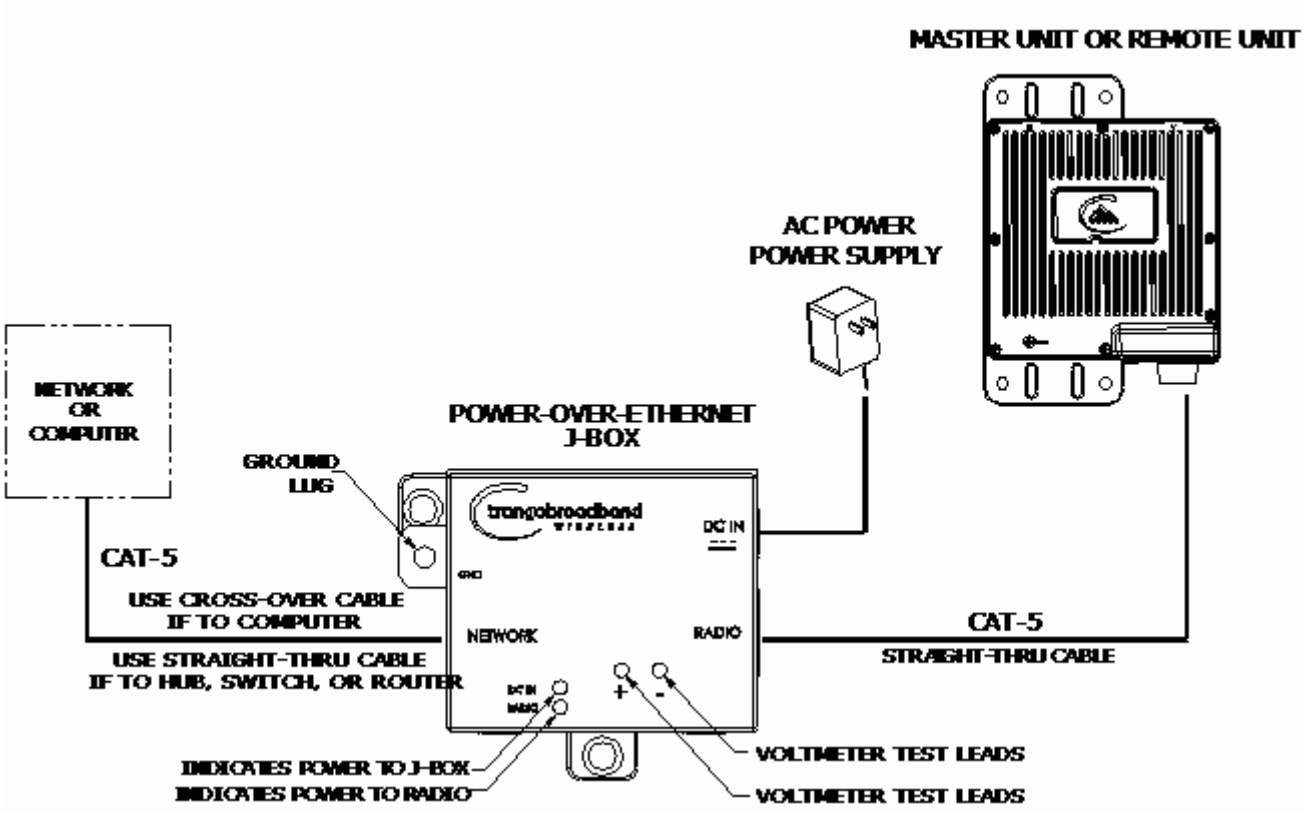
Chapter 2 Getting Started

It is always a good idea to first provision and test the radios on the bench before deploying them in the field. This is a particularly useful exercise for the first time user.

Connections and Power

- Connect a Cat-5 (straight through) Ethernet cable (we recommend shielded twisted pair) between the ODU (out door unit) port of the J-box and the RJ-45 connector on the radio. Note that this cable will carry power-over- Ethernet (PoE).
- If connecting to a COMPUTER, use a Cross-Over Ethernet cable from the NET port of the J-box to the computer's Ethernet port.

  If connecting to a HUB, SWITCH, or ROUTER, use a Straight-Thru cable.
- Plug the AC adapter into an AC outlet.



Both green LEDs on the J-box should be lit, indicating power is present at the Power-over-Ethernet box as well as at the radio.

You are now ready to configure the radio via the Ethernet port. After reboot, the Radio Power LED may take several seconds before lighting. The radio requires approximately 45 seconds to boot.

Configuration Tools

P5055M radios can be configured using either the Command Line Interface (CLI), or the Web Browser (HTTP) interface. The CLI method provides slightly more functionality.

In addition, radio management can be done with or without VLAN tagging. Management within a VLAN (with tagging) is described in the **Management VLAN** section below.

This text covers configuration through the CLI without a VLAN. For HTTP configuration please see Appendix A.

Telnet

Open a command prompt (DOS) session on your PC. Open a Telnet session by typing:

telnet <ip address of radio>

Example:
C:>telnet 192.168.100.100

Note: All Trango radios are pre-configured at the factory with a default IP address of 192.168.100.100.

You will be greeted with current hardware and firmware information and prompted for a password. Type in the password and press enter. The factory default read/write password is **trango**.

```
Welcome to Trango Broadband Wireless, TrangoLINK-45 DFS PtP-P5055M 2p0r1D07061104
Password:
Login as read/write.
#>
```

Note: Type ***help*** for a listing of all CLI commands. Type ***help [<command>]***, for the syntax of a particular command.

Note: If you cannot access the radio management functions via the Ethernet port, check all cable connections and ensure that your PC is set up with a properly routable subnet.

Changing Password

Three types of passwords are used in the TrangoLINK-45 system:

rw	read write password. User can view and update all syste parameters
ro	read only password. User can view system information only
Upgrade	Firmware upgrade password. This password must be included in the file name of the main image and web browser firmware files during the TFTP upload process.

Use the ***password*** *<ro|rw|upgrade>*command to change the various

passwords. Examples:

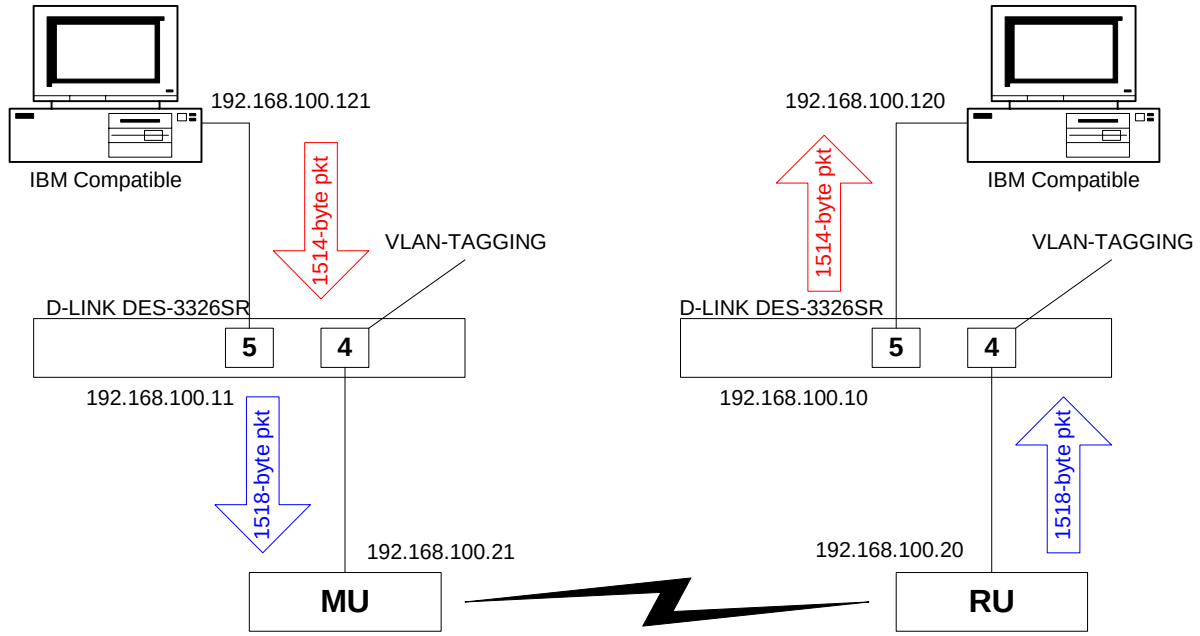
```
#> password rw
New Password (4 to 16 characters): *******
Confirm Password: *******
Success.

#> password ro
New Password (4 to 16 characters): ******
Confirm Password: ******
```

```
Success.
```

Management VLAN

The TL-45 is capable of management from within a VLAN with the help of an external switch. Below is an example set up how TL-45 works with VLAN tagging for management access.

Management VLAN Example:



TL- 45 set up example for management within a VLAN other than default VLAN 1.

Note: IP addresses used in the figure are for example only.

- Default management VLAN on Trangolink-45 is VLAN 1.
- If you want to configure management VLAN other than VLAN 1 than please follow below procedure.

Note: A managed switch is mandatory to make management within a VLAN possible. The switch must be tagging packets. If you want to use management VLAN other than default VLAN than it is recommended to test it on the bench first than deploy in the field.

Setup

Open a command prompt (DOS) session on your PC. Open a Telnet session by typing:

telnet <ip address of radio>

Example:

C:>telnet 192.168.100.100

Note: All Trango radios are pre-configured at the factory with a default IP address of 192.168.100.100.

You will be greeted with current hardware and firmware information and prompted for a password. Type in the password and press enter. The factory default read/write password is *trango*.

```
Welcome to Trango Broadband Wireless, TrangoLINK-45 DFS PtP-P5055M 2p0r3D09091501

Password:

Login as read/write.
```

Check the VLAN status

```
#>vlan
[current] No VLAN
[config] No VLAN
Success.
```

Enable VLAN management with VID 2 with class of service queueing enabled

```
#>vlan 2 cos
Success.
```

Enable VLAN management with VID 2 with class of service queueing disabled

```
#>vlan 2 nocos
Success.
```

Note: cos and nocos will be chose upon customer needs. If cos is enabled, packets with a higher priority tag (COS field in the VLAN tag) will be forwarded first through the radio in the event that an overloading/burst condition occurs at the Ethernet port or the rate shifting reduces the available throughput at the RF link below the level coming into the Ethernet port. The queuing method is strict with priority 7 being the highest and priority 0 being the lowest.

It is recommended to give the management VLAN the highest priority (7) to ensure communication with the radio in a heavy traffic situation.

Useful Commands to configure management VLAN on Trangolink45:

vlan	show current status
vlan none	Disable vlan
vlan <id,2..4095> cos	enable and assign vlan tag with cos
vlan <id,2..4095> nocos	enable and assign vlan tag without cos

Note: Type help for a listing of all CLI commands. Type help [<command>], for the syntax of a particular command.

Note: If you cannot access the radio management functions via the Ethernet port, check all cable connections and ensure that your PC is set up with a properly routable subnet.

Troubleshooting Ethernet Connections

If you cannot telnet into the radio or open an HTTP browser session, check your cable connections to ensure proper use of cross-over vs. straight-through cable, and ensure your PC's subnet is routable to the radio's IP address.

System Information (sysinfo) Page

To display system configuration and status information type the command s***ysinfo***. The sysinfo screen is divided into 7 sections (0 –7):

Section	Description
0	Hardware/Firmware versions & system uptime (since reboot)
1	Mac, serial number, and IP configuration information
2	Opmode, RF info, speed, and peer connection status
3	RF channel table
4	Area code information denotes which channels and power limits are available based on region code of the radio. Area code is set by the factory and cannot be altered by the user.
5	ARQ status, encryption, Auto-rate shift, remarks, and LED RSSI function
6	Ethernet TX/RX statistics.

Sysinfo Example:

```
#> sysinfo

******************************** 0 ********************************

[Model] P5055M
[Area Code]
0 [Unit
Type] RU
[Hardware Version] 5055
[Firmware Version] 2p0r1D07061104
[System Up Time] 7 day(s) 03:58:16

******************************** 1 ********************************

[MAC] 00 01 DE 61 59 F7
[S/N] 6380023
[IP] 10.8.2.149 [Subnet Mask] 255.255.255.224 [Gateway] 10.8.2.129

******************************** 2 ********************************

[Radio Temp] 34 C   [PoE Voltage] 14.2 V
[Opmode] on [Default Opmode] on
[Active Channel] 22 h [Freq] 5840 MHz
[Speed] 6 Mbps [Tx Power] 0 dBm [Power Range] -10..22 dBm
[Peer ID] DE6159FA [Status] disconnect  [RSSI] n/a
[Peer IP Config] n/a
[DFS Status] idle


******************************** 3 ********************************

Channel Table: (MHz, n/a: not available in current area)
[Ch#01] 5265 dfs [Ch#02] 5285 dfs [Ch#03] 5305 dfs [Ch#04] 5325 dfs
[Ch#05] 5500 dfs [Ch#06] 5520 dfs [Ch#07] 5540 dfs [Ch#08] 5560 dfs
[Ch#09] 5580 dfs [Ch#10] 5600 dfs [Ch#11] 5620 dfs [Ch#12] 5640 dfs
[Ch#13] 5660 dfs [Ch#14] 5680 dfs [Ch#15] 5700 dfs [Ch#16] 5735
[Ch#17] 5755  [Ch#18] 5775       [Ch#19] 5795       [Ch#20] 5815
[Ch#21] 5835  [Ch#22] 5840       [Ch#23] 5840       [Ch#24] 5840

Default Channel Table:
[Ch#01] 5265 dfs [Ch#02] 5285 dfs [Ch#03] 5305 dfs [Ch#04] 5325 dfs
[Ch#05] 5500 dfs [Ch#06] 5520 dfs [Ch#07] 5540 dfs [Ch#08] 5560 dfs
[Ch#09] 5580 dfs [Ch#10] 5600 dfs [Ch#11] 5620 dfs [Ch#12] 5640 dfs
[Ch#13] 5660 dfs [Ch#14] 5680 dfs [Ch#15] 5700 dfs [Ch#16] 5735
[Ch#17] 5755  [Ch#18] 5775       [Ch#19] 5795       [Ch#20] 5815
[Ch#21] 5835  [Ch#22] 5840       [Ch#23] 5840       [Ch#24] 5840

******************************** 4 ********************************

[Area Code] 0
RF Band #1 (5180..5260 MHz) Disabled
RF Band #2 (5265..5325 MHz) [Power Range] -10..10/10/10/10 dBm
RF Band #3 (5500..5700 MHz) [Power Range] -10..10/10/10/10 dBm
RF Band #4 (5735..5840 MHz) [Power Range] -10..22/21/19/17 dBm
```

```
********************************* 5 *********************************

[Tx MIR] 50000 Kbps
[ARQ] on
[Encrypt] off [Key] 0011 2233 4455 6677 8899 AABB CCDD EEFF
[Auto Rate Shift] on
[Auto Scan MU] off
[RSSI LED] on

[Remarks] Remarks

********************************* 6 *********************************

[Eth Config] ANEG
[Eth Status] 100 FDX

[Eth In] 35,262,413 bytes 3 Kbps
[Eth Out] 9,201,047 bytes 51 Kbps
[RF In]         0 bytes   0 Kbps
[RF Out]         0 bytes   0 Kbps

[ARQ Retransmission] 0 pkts

Success.
#>
```

To view only a particular section of the sysinfo screen, type sysinfo followed by the desired section number.

Example:

```
#> sysinfo 2

********************************* 2 *********************************

[Radio Temp] 34 C   [PoE Voltage] 14.2 V
[Opmode] on [Default Opmode] on
[Active Channel] 22 h [Freq] 5840 MHz
[Speed] 6 Mbps [Tx Power] 0 dBm [Power Range] -10..22 dBm
[Peer ID] DE6159FA [Status] disconnect  [RSSI] n/a
[Peer IP Config] n/a
[DFS Status] idle

Success.
#>
```

Each of the parameters within the sysinfo screen is defined below

Section 0

[Model]	Radio Model # (P5055M)
[Unit Type]	User defined Unit Type (MU or RU)
[Hardware Version]	Hardware version set by factory (5010)
[Firmware Version]	Current firmware version loaded in radio
[System Up Time]	Time since last reboot or power cycle

Section 1

[MAC]	MAC address of radio

[S/N]	Serial Number of Radio
[IP]	User defined IP Address of radio
[Subnet Mask]	User entered IP Subnet Mask
[Gateway]	User entered IP address of the default router or gateway on the local Ethernet segment

Section 2

[PoE Voltage]	The voltage the ODU received from the Jbox.
[Radio Temp]	The internal radio temperature in Celsius
[Opmode]	Operation mode of the radio: ON = transmitting, OFF= not transmitting
[Default Opmode]	Opmode which the radio defaults to after
reboot. [Active Channel]	Active RF Channel and Antenna polarization
[Freq]	Frequency of active channel
[Speed]	Modulation Speed (6,12,18,24,36, 54 Mbps)
[Tx Power]	Transmit Power
[Power Range]	Allowable power range for chosen Frequency (dBm)
[Peer ID]	MAC Address of remote radio
[Status]	Connection status of remote radio (connected or disconnected)
[RSSI]	Measured signal strength from remote radio (dBm)
[Peer IP Config]	Remote radio's IP subnet, and default Gateway configuration
[DFS Status]	The current status of DFS.

Section 3

Channel Table: (MHz, n/a: not available in current area)

[Ch#01] 5265 dfs	[Ch#02] 5285 dfs	[Ch#03] 5305 dfs	[Ch#04] 5325 dfs
[Ch#05] 5500 dfs	[Ch#06] 5520 dfs	[Ch#07] 5540 dfs	[Ch#08] 5560 dfs
[Ch#09] 5580 dfs	[Ch#10] 5600 dfs	[Ch#11] 5620 dfs	[Ch#12] 5640 dfs
[Ch#13] 5660 dfs	[Ch#14] 5680 dfs	[Ch#15] 5700 dfs	[Ch#16] 5735
[Ch#17] 5755	[Ch#18] 5775	[Ch#19] 5795	[Ch#20] 5815
[Ch#21] 5835	[Ch#22] 5840	[Ch#23] 5840	[Ch#24] 5840

Section 4

[Area Code]	Region (country code). Defines allowable frequencies. Area code is set by the manufacturer and can not be altered by the user.
RF Band #1 (5180..5240 MHz)	Disabled
RF Band #2 (5260..5325 MHz)	[Power Range] -4..7/7/7/7 dBm
RF Band #3 (5480..5720 MHz)	Disabled
RF Band #4 (5735..5835 MHz)	[Power Range] -4..21/19/18/17 dBm

Section 5

[Tx MIR]	Maximum Information Rate (Mbps). User may set Tx MIR in MU and RU to different values.
[ARQ]	Automatic Retransmit Request (On or Off)
[Encrypt]	Encryption (On or Off)
[Key]	Hexadecimal Encryption Key (must match in MU and RU)
[Auto Rate Shift]	Automatic Rate Shift (adaptive modulation) (On or Off)
[Auto Scan MU]	Auto Scan MU (RU setting only) (On or Off)
[RSSI LED]	Enable or disable RSSI LEDs on bottom of radio. Disabling RSSI LEDs improves system performance.

[Remarks]	User entered remarks up to 256 characters. Field accepts alpha numeric's only. Special characters (!@#$%^&*()\?/) require quotations.

Section 6

[Eth Config]	Configuration setting of Ethernet port which will also be ANEG
[Eth Status]	The current status of Ethernet port 100FDX/100HDX/10FDX/10HDX
[Eth In]	Counter for Ethernet packets which entered via the Ethernet port
[Eth Tx]	Counter for Ethernet packets which exited via the Ethernet port
[RF Rx]	Counter for Ethernet packets which entered via the wireless
link [RF Tx]	Counter for Ethernet packets which exited via the wireless link
[ARQ Retransmissions]	Counter for the number of packets retransmitted via ARQ.

Chapter 3 Configuration

Key Concepts

Prior to configuring the radios it is important to understand several key concepts:

Master Unit (MU)	The MU is typically considered the primary radio within the link. For management purposes it is recommended to install the MU closest to the head-end of the network.
Remote Unit (RU)	The RU is typically installed at the remote end of the link. The primary distinction between the MU and RU is that when the radios are not associated, the MU will transmit and the RU will listen until the wireless link is established.
Peer ID	The Peer ID is defined as the MAC address of the opposite radio. In other words, the Peer ID of the MU is the RU's MAC address and the Peer ID of the RU is the MU's MAC address. Authentication is controlled by the MAC address of each radio.
Opmode	The radio has two modes of operation: 1) Opmode OFF – The radio is in a state which will not allow the establishment of a link with another radio. This state is mainly used for administration and pre- installation site survey 2) Opmode ON – The radio is in a state which allows it to establish a link to another radio if the proper settings are made. This is the normal "in service" state of the radio.
Default Opmode	Opmode (on or off) which the radio enters after reboot. Note: if you telnet into a radio within 30 seconds after reboot, the radio will remain in opmode OFF even if the default opmode is ON.

Essentials to Establish a Wireless Link

Configuration of the TrangoLINK-45 system is simple and at a minimum requires the following settings:

1. Designate one radio's unit type (utype) as the Master Unit (MU) and one unit as the Remote Unit (RU).
2. Program Peer ID in each radio.
3. Set MU and RU to same channel and antenna polarization
4. Set default Opmode to "ON" so that radio will automatically enter opmode after reboot.
5. Turn radios Opmode "ON".

If all of these parameters are met, and if the MU and RU are within range and properly aligned, the wireless link will automatically establish itself and Ethernet traffic will begin to pass between the radios.

Master Unit Configuration

Start a telnet session with one of the radios. Follow these steps for configuration.

1. Set the Unit Type (utype) to MU in one radio. (default for all radios is RU)
```
#> utype mu
Success.
#>
```

2. Set the Peer ID with the MAC address of the RU. Only use the last 8 digits of the MAC address.
```
#> peerid de1B7850
Success.
#>
```

3. Set channel and polarization. (in this example set the channel to 2 and polarization to H).
```
#> freq 2 h
Ch# 23 h (5280 MHz)
Success.
```

4. Set default Opmode to ON.
```
#> defaultopmode on
Success.
```

5. Reboot the radio
```
#> reboot
```

(NOTE: It is critical to reboot after the utype has been changed before turning Opmode "On")

After the radio reboots, start another telnet session with the radio and proceed as follows:.

1. Turn Opmode ON.
```
#> opmode on
Success.
```

.

Remote Unit Configuration

Configure the RU in the same manner as the MU. Since the default unit type (utype) is RU, you do not need to set this parameter.

1. Set the Peer ID with the MAC address of the MU. Only use the last 8 digits of the MAC address.
```
#> peerid de1B7842
Success.
#>
```

2. Set channel and polarization. (in this example set the channel to 2 and polarization to H).
```
#> freq 2 h
Ch# 2 h (5280 MHz)
Success.
```

3. Set default Opmode to "ON."
```
#> defaultopmode on
Success.
```

4. Reboot the radio
```
#> reboot
```

(NOTE: It is critical to reboot after the utype has been changed before turning Opmode "On")

After the radio reboots, start another telnet session with the radio and proceed as follows:.

1. Turn Opmode ON.

```
#> opmode on
Success.
```

Establishing a Wireless Link

If the MU and RU are properly configured and in opmode "ON", the two radios will automatically begin the authentication process and become connected. To determine if the two radios are connected, type the **sysinfo 2** command.

Example:

```
#> sysinfo 2

******************************** 2 ******************************** [Radio
Temp] 34 C        [PoE Voltage] 14.2 V
[Opmode] on [Default Opmode] on
[Active Channel] 22 h [Freq] 5840 MHz
[Speed] 6 Mbps [Tx Power] 0 dBm [Power Range] -10..21 dBm
  [Peer ID] DE1B784B [Status] connected          [RSSI] -75 dBm
[Peer IP Config] 10.254.1.3 255.255.255.248 10.254.1.1 [DFS
Status] idle

Success.
#>
```

The [status] field indicates whether the MU and RU are connected or disconnected. If connected, the MU and RU will automatically start passing Ethernet traffic over the wireless link.

Changing IP Address

Use the ***ipconfig*** command to change the radio's ip address, subnet mask and gateway. Syntax: ***ipconfig [<ip> <subnet> <gateway>]***

```
Example:
#> ipconfig 10.8.2.140 255.255.255.240 10.8.2.129
New configuration: [ip] 10.8.2.140 [subnet mask] 255.255.255.240 [gateway]
10.8.2.129

save and activate ? (y/n) [ATTN] Telnet session will be terminated in 30 seconds.
Success.
#>
```

LEDs

LEDs are visible on the unit's PCB between the reset button and the RJ-45 connector. The function of each LED is described below:

LNK (green)
Green: On solid for an established 10BaseT or 100BaseT Ethernet Link.

SPEED
Green: Solid if 100BaseT, Blinks only if there is activity (TX or RX) on the network when a 100 MBit connection is established. Off if a 10BaseT connection is established or if there is 10BaseT activity.

RSSI (4 LEDs)
Amber: Four LEDs
In all modes except "Survey", the unit's four yellow LEDs indicate the level of RF signal being received from a VALID MU or RU as appropriate.

Yellow LED 1 : Begins blinking when RSSI is greater or equal to –90 dBm. On solid at –85 dBm. This is the Leftmost LED.

Yellow LED 2 : Begins blinking when RSSI is greater or equal to –80 dBm. On solid at –75 dBm.

Yellow LED 3 : Begins blinking when RSSI is greater or equal to –70 dBm. On solid at –65 dBm.

Yellow LED 4 : Begins blinking when RSSI is greater or equal to –60 dBm. On solid at –55 dBm. This is the rightmost LED.

If no VALID MU or RU signal is detected the LEDs will not be on at all.

In addition, these 4 LEDs shall flash ON for 2 seconds, then OFF for 2 seconds to indicate the 'factory reset' button has been activated and the reset successful.

ASSOCiation LED (green):
The ASSOC led blinks at the following rates:

- Once every second when unit is powered on but opmode is OFF.
- Twice per second while in opmode ON and scanning for an MU or RU.
- Solid after unit is associated with the RU or MU.

RF Link Loopback Test (linktest command)

The ***linktest*** command is the primary tool to assess the quality of the link when opmode is on. The linktest command tests the throughput and packet error rate (PER) on the current channel for each direction at all speeds and reports results. This command also provides RSSI for both ends of the wireless link. The command can be run from either the MU or the RU. The linktest uses FEC but does NOT use ARQ, so all errors on the link are reported. Throughput numbers represent the absolute maximum bi-directional capacity including the management header (which is not available for user payload) so actual user throughput measurements will be slightly less.

In running the linktest command the user must specify the modulation speed for each end of the link. Command format: **linktest <loc speed> <peer speed>.** Valid modulation speeds are: 6, 12, 18, 24, 36,48, and 54 Mbps. Lower speeds will result in fewer dropped packets.

Example:

```
# linktest 24 24
local tx rate = 24
Mbps peer      tx
rate = 24 Mbps packet
size = 1600 bytes
# of packets per period = 1000
# of Cycle = 10
0> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
1> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
2> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
3> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
4> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
5> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
6> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
7> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.00 Mbps
8> [tx] 1000 [rx] 1000 [rssi] -36 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps
9> [tx] 1000 [rx] 1000 [rssi] -37 peer: [tx] 1000 [rx] 1000 [rssi] -40 ->       22.01 Mbps

--> [tx] 10000 [rx] 10000 [rssi] -36  peer: [tx] 10000 [rx] 10000 [rssi] -40
--> [Local PER]0.00 %   [Peer PER]     0.00 %

Success.
#>
```

In this example the linktest was run at 24 Mbps at each end of the link. The results indicated 10 cycles of 1000 packets were transmitted and received from each end of the link without error. Actual achievable throughput is measured at 22 Mbps.

Link Speed & Power Settings

Users may change the radio's over-the-air data rate and conducted output power using the ***speed*** and ***power*** commands. Keep in mind that the lower data rates offer higher receiver sensitivity and higher allowable conducted RF power in the ISM band. The following table shows the relation between speed settings, modulation scheme, receiver sensitivity, and allowable maximum power settings for each frequency band. The lowest power setting for all bands is –10 dBm.

- US / IC MODELS*

Speed Setting (over-the-air rate) (Mbps)	Modulation Scheme	Receiver Sensitivity (dB)	Max Power 5.18 to 5.24 GHz (dBm)	Max Power 5.265- 5.325, 5.5 to 5.7 GHz (DFS-UNII) (dBm)	Max Power 5.735 to 5.84 GHz (ISM) (dBm)
6	BPSK	-92	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+21
12	QPSK	-87	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+19
18	QPSK	-85	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+19
24	16QAM	-84	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+18
36	16QAM	-80	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+18
48	64QAM	-75	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+17
54	64QAM	-73	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+17

* NOTE: IC Model does not include the following frequency range 5600-5650MHz

- EU MODELS

Speed Setting (over-the-air rate) (Mbps)	Modulation Scheme	Receiver Sensitivity (dB)	Max Power 5.18 to 5.24 GHz (ETSI) (dBm)	Max Power 5.26- 5.32, 5.5 to 5.7 GHz (ETSI) (dBm)	Max Power 5.725 to 5.85 GHz (dBm)
6	BPSK	-92	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
12	QPSK	-87	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
18	QPSK	-85	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
24	16QAM	-84	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
36	16QAM	-80	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
48	64QAM	-75	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
54	64QAM	-73	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA

- OE MODELS

Speed Setting (over-the-air rate) (Mbps)	Modulation Scheme	Receiver Sensitivity (dB)	Max Power 5.18 to 5.24 GHz (ETSI) (dBm)	Max Power 5.26- 5.32, 5.5 to 5.7 GHz (ETSI) (dBm)	Max Power 5.725 to 5.85 GHz (dBm)
6	BPSK	-92	+14	+14	+21
12	QPSK	-87	+13	+13	+19
18	QPSK	-85	+13	+13	+19
24	16QAM	-84	+12	+12	+18
36	16QAM	-80	+12	+12	+18
48	64QAM	-75	+11	+11	+17
54	64QAM	-73	+11	+11	+17

In this example the user sets the power to 19dBm and the speed to 24 Mbps:

```
#> power 19
Execution in progress...
.
19 dBm (-4..19)
Success.
#> speed 24
24 Mbps
Success.
#>
```

MU Autoscan Feature Description

This feature allows the RU to actively search all channels and polarizations for its peer MU in the event of a disassociation. This feature is useful if the user frequently changes the channel/polarization of the MU . If enabled, the *autoscanmu* routine in the RU performs a search for the peer MU by actively scanning all available channels and polarizations. **NOTE: Autoscanning is always active when operating on DFS channels.**

Notes regarding the autoscanmu feature:

1) The RU will not activate the autoscan process after first 60 seconds of turning on opmode.
2) The RU will start the auto scan process If RU loses association for more than 10 seconds,.
3) The whole process will scan ALL (DFS and non DFS) available frequencies and polarizations in channel tables.
4) For each frequency, radio will survey both polarizations, H and V. It will record the following information:
   - Association
   - average RSSI of receiving P5055M packets
5) After scanning all available frequencies in the channel plan, the radio will select the channel based on the strongest average RSSI for receiving packets.
6) If no channel is selected after completing the cycle, the process will start again.

IMPORTANT NOTE FOR -EU MODELS:

The RF transmit power limits are lower for the lower (5.26 to 5.35 GHz) band than the upper (5.5 to 5.7 GHz band) by 7 dB.

It is possible that after a radar event occurs on a link operating in the upper band, the MU may choose a channel in the lower band. The max transmit power will be reduced on both ends of the link by 7 dB. If the link budget does not support this reduced transmit power, the link may not re-establish or may re-establish at a much lower speed.

It is recommended that fade margins greater than 10 dB always be used to prevent the situation described above.

Example:

```
#> autoscanmu on
Success.
#>
```

Automatic Rate Shifting Feature Description

With autorateshift feature enabled, the radios will automatically renegotiate the modulation method and speed speed to maximize wireless link integrity. The link speed will vary depending on two factors: 1) the number of ARQ errors received, 2) successful processing of special link assessment packets sent in both the current and next higher speed. The radio will shift to the next higher in speed when no errors are detected. The radio will shift down in speed if error rate is excessive.

Notes regarding the autorateshift feature:

1. The radio will begin initial speed test when upon association to peer radio. There are 40 steps and around 50 seconds to complete this initial test. The radio will send link assessment packets (3600 byte packets at a rate of 100 packets per second) at the highest speed (54 Mbps). The radio will deliver payload at the speed which is specified before association. If the assessment packet dropping rate is higher than 10 percent, the speed test will decrease the speed for assessment packets. If the current payload speed is higher than the speed of assessment packet, the radio will set the current payload speed to be the same as the assessment packet's speed. If the current payload speed is lower than the assessment packet's speed and more than 500 assessment packets have been transmitted, the radio will set the payload speed to be the same as assessment packet's speed.

2. After completion of initial speed test, the radio will set the payload speed to be the same as the final speed of initial speed test.

3. The radio will check link quality and adjust payload speed periodically.
    a. The radio will increase payload speed every 60 seconds, if
        i. Speed test which is running at higher speed is successful. –and-
        ii. Payload's ARQ retransmit rate is less than 10 percent.
    b. Radio will decrease payload speed every 10 seconds, if
        i. Speed test which is running at payload speed is failure. –and-
        ii. Payload's ARQ retransmit rate is higher than 10 percent.

4. Payload speed can be changed manually when auto rate shift is on. But the speed setting will not be sustained.

Example:

```
#> autorateshift on
Success.
#>
```

Encryption Feature Description

The TrangoLINK-45 system offers 128 bit proprietary encryption which may be turned on or off by the user. The HEX encryption key must be set in both the MU and RU. Users can expect faster payload speeds with encryption turned off as compared to with encryption turned on.

Example:

```
#> encrypt on
Success.
#> encrypt key 1111 2222 3333 4444 5555 6666 7777 8888
argc = 10
Success.
#>
```

MIR Feature Description

Maximum Information rate is configurable on both the MU and RU. The MIR function is performed on the transmit side only and is based on a one second timing interval. During each one second timing interval, the total bits transferred is compared to the MIR limit configured by the user. When the limit is exceeded, no more data is sent and the packets in the queue will be dropped. This function is useful for reserving more bandwidth in one direction than the other. If left wide open, the system will respond to bandwidth demand as needed, allowing the full bandwidth of the channel to be used by either direction.

Example:

```
#> mir 10000
Success.
#>
```

Command Reference Listing

The complete command set reference is provided below. You can also view a complete listing of all CLI commands by typing *help*.

Command Syntax	Description
antenna [h|v]	Set or display antenna setting. H=Horizontal polarity, V=vertical polarity.
arq [on|off]	Enable or disable Auto Retransmit Request (ARQ). With ARQ enabled, the TrangoLINK-45 system will retransmit packets which are detected as missing or corrupted. Default setting=ON.
autorateshift [on|off]	Enable or disable automatic rate shift feature. With autorateshift enabled, the radios will automatically renegotiate speed setting to maximize wireless link integrity. Default setting=OFF. Notes: • Radio will start to perform diagnostic speed test approximately 50 seconds after association. • Radio will set new speed after finishing speed test. • Radio will check link quality for increasing speed every 60 seconds. • Radio will check link quality for decreasing speed every 10 seconds. • Link quality is based on ARQ retransmit statistics and speed assessment packets. • Radio's speed can be changed manually when auto rate shift is on, however the speed will not be sustained. • If auto rate shift is turned on after association, the radio will not perform speed test. • If auto rate shift is turned off after associated, radio will not perform regular link quality assessment.
8021p [on|off]	enable or disable 802.1p
autopl [on|off]	enable or disable auto power leveling
autopl targetrssi <dB, -55..-70>	set target rssi, default = -62 In RU, if it is DFS channel, autopl will always on

autoscanmu [on|off]	Enable or disable auto scan MU (RU only). Default setting=OFF . When autoscanmu is turned on, the RU will automatically scan all channels and polarizations searching for its peer MU. Once the RU detects the MU it will stop scanning and lock onto the channel of the MU. The autoscan feature is useful in cases where the user changes the channel at the MU because the RU will automatically search for the new channel of the MU. Note: auto-scanning may take as long as 5 minutes. Notes: • RU will not perform auto scan during the first 60 sec after opmode is turned on. • RU will initiate auto scan cycle after losing sync for 10 seconds. • RU will scan all “available channels” and antenna polarizations. • After finishing scan cycle, RU will pick the best channel and antenna by a) has sync and b) has highest packet rssi. Afterwards RU will change to that channel with max power. • If no channel is selected after finishing scan cycle, RU will initiate auto scan cycle again after 10 seconds.

defaultopmode [on|off]	Set or display default opmode. Radio must be set to opmode ON to establish wireless link. Default setting=OFF
encrypt [on|off]	Enable or disable proprietary 128 bit tx encryption. Default setting=OFF
encrypt key <key>	Change encryption key (128 bits) <key> = xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx
exit	Exit telnet session
freq [<ch#> <antenna>]	Set or display channel and antenna selection.
freq writechannel <ch#> <freq>…	Modify channel table, up to 6 channels at a time.
freq writechannel default	Restore factory default channel table.
help [<command>]	Display command usage and syntax.
ipconfig [<ip> <subnet> <gateway>]	Change ip configuration. <ip> = ip address <subnet> = subnet mask <gateway> = gateway ip address
linktest <local tx rate> <peer tx rate> [<pkt size> [<# of pkt> [<# of cycle>]]]	RF link loopback test . This is the primary loopback test utility for evaluating over-the-air link quality. Provides link reliability information and dropped packet statistics. Standard linktest transmits 1600 byte packets, 1000 packets per second for 10 cycles. User can specify packet size, quantity of packets, number of cycles <tx rate> = 6,12,18,24,36,48,54 Mbps
mir [<kbps>]	Set or display tx maximum information rate (MIR). MU and RU can be set with different mir for asymmetric upload and download. <kbps> = 100..50000
opmode [on|off]	Set or display operation mode (on or off)
password <ro|rw|upgrade>	Change password. <ro> = for read-only <rw> = for read-write <upgrade> = for upgrading firmware
peerid [<peer device id>]	Set or display peer device id.
power [<dBm>]	Set or display tx power.. <dBm> is limited by area (ref: “sysinfo 4”)
reboot	Reboot unit.
remarks	Enter user remarks up to 80 characters.
reset	Restore all factory defaults except ipconfig and passwords.
rssi	Display RF relative signal strength indication (rssi) from peer radio.
rssiled [on|off]	Enable or disable rssi LED update.
speed [<tx rate>]	Set or display tx rate <tx rate> = 6,12,18,24,36,48,54 Mbps
survey [<sec>]	Display noise floor for current channel . <sec> = period 10..3600 default = 10
survey <sec> all	Display noise floor for all available channels.
survey <sec> [<ch#> [..]]	Display noise floor for selected channels.
sysinfo	Display all system information.

sysinfo [[<part #> [<part #> [..]]]]	Display system information and status <part #> = 0..6 part 0: up time and version information part 1: MAC address and IP configuration part 2: RF link status part 3: channel table part 4: region code and power limitations part 5: switch settings and remarks
syslog	Display system log.
tftpd [on|off]	Enable or disable tftpd (used for firmware upgrades).
utype [mu|ru]	Set or display unit type.
vlan	show current status
vlan none	Disable vlan
vlan <id,2..4095> cos	enable and assign vlan tag with cos
vlan <id,2..4095> nocos	enable and assign vlan tag without cos

Chapter 4 Deployment & Installation

Once you are familiar with the basic operation of the radios you are ready for deployment in the field. The deployment process consists of the following steps:

1. Site Selection
2. Site survey at MU and RU sites
3. MU installation
4. RU installation and antenna alignment
5. Link test

Site Selection

Proper site selection for your MU will help ensure a successful deployment. Site selection will depend on a wide variety of factors, but from the radio's performance standpoint, please consider the following:

- Path from MU to RU should provide unobstructed line-of-sight (LOS), thus it is advisable to place MU as high as possible on a tall building or tower.
- Ethernet cable limit is 100 meters from Ethernet device (router, switch) to radio.
- Radios should never be deployed without proper grounding.
- Consider nearby sources of interference that could degrade the performance of the radio. Mount radios as far from sources of interference as possible.

Site survey

The radios provide an on-board site survey tool which measure the average and peak noise levels on any given channel.

To use the survey tool, the radio must be in Opmode "OFF." The survey can be performed for any specified amount of time (in seconds), and for specific channels or for all channel/antenna polarization combinations.

Prior to performing the site survey, place the radio in the installation spot, and aim the radio in the desired

direction. The survey command will display the average and peak noise floor for each channel as well as average

and peak RSSI
received during the same period for 802.11 packets.

Users may run any of the following variations of the survey command:

survey	display noise floor for current channel based on 10 second scan.
survey [<sec>]	display noise floor for current channel for period <sec> 10..3600 seconds survey
<sec> all	display noise floor for all available channels where <sec> = period per channel
survey <sec> [<ch#> [..]]	display noise floor for selected channels (max 4) where <sec> = period per channel
	<ch#> = channel number

Example:

```
#> survey 10 all
Press 'q' to stop.

        noise floor (peak/avg dBm)  rssi by pkt (peak/avg dBm)

Ch   1 h 5265   :   -97 / -98       n/a / n/a
Ch   1 v        :   -97 / -98       n/a / n/a
Ch   2 h 5285   :   -97 / -98       n/a / n/a
Ch   2 v        :   -97 / -98       n/a / n/a
Ch   3 h 5305   :   -97 / -98       n/a / n/a
Ch   3 v        :   -97 / -98       n/a / n/a
Ch   4 h 5325   :   -98 / -98       n/a / n/a
Ch   4 v        :   -97 / -98       n/a / n/a
Ch   5 h 5500   :   -98 / -98       n/a / n/a
Ch   5 v        :   -98 / -98       n/a / n/a
Ch   6 h 5520   :   -98 / -98       n/a / n/a
Ch   6 v        :   -98 / -98       n/a / n/a
Ch   7 h 5540   :   -98 / -98       n/a / n/a
Ch   7 v        :   -98 / -98       n/a / n/a
Ch   8 h 5560   :   -98 / -98       n/a / n/a
Ch   8 v        :   -98 / -98       n/a / n/a
Ch   9 h 5580   :   -98 / -98       n/a / n/a
Ch   9 v        :   -98 / -98       n/a / n/a
Ch 10 h 5600    :   -98 / -98       n/a / n/a
Ch 10 v         :   -98 / -98       n/a / n/a
Ch 11 h 5620    :   -98 / -98       n/a / n/a
Ch 11 v         :   -98 / -98       n/a / n/a
Ch 12 h 5640    :   -98 / -98       n/a / n/a
Ch 12 v         :   -98 / -98       n/a / n/a
Ch 13 h 5660    :   -98 / -98       n/a / n/a
Ch 13 v         :   -98 / -98       n/a / n/a
Ch 14 h 5680    :   -98 / -98       n/a / n/a
Ch 14 v         :   -98 / -98       n/a / n/a
Ch 15 h 5700    :   -98 / -98       n/a / n/a
Ch 15 v         :   -98 / -98       n/a / n/a
Ch 16 h 5735    :   -63 / -98       n/a / n/a
Ch 16 v         :   -71 / -98       n/a / n/a
Ch 17 h 5755    :   -91 / -98       n/a / n/a
Ch 17 v         :   -98 / -98       n/a / n/a
Ch 18 h 5775    :   -98 / -98       n/a / n/a
Ch 18 v         :   -98 / -98       n/a / n/a
Ch 19 h 5795    :   -98 / -98       n/a / n/a
Ch 19 v         :   -98 / -98       n/a / n/a
Ch 20 h 5815    :   -98 / -98       n/a / n/a
Ch 20 v         :   -98 / -98       n/a / n/a
Ch 21 h 5835    :   -98 / -98       n/a / n/a
Ch 21 v         :   -98 / -98       n/a / n/a
Ch 22 h 5840    :   -98 / -98       n/a / n/a
Ch 22 v         :   -98 / -98       n/a / n/a
Ch 23 h 5840    :   -98 / -98       n/a / n/a
Ch 23 v         :   -98 / -98       n/a / n/a
Ch 24 h 5840    :   -98 / -98       n/a / n/a
Ch 24 v         :   -98 / -98       n/a / n/a
Success.
#>
```

Channel Planning

Based on the results of the site survey at each end of the link, choose a channel which offers the lowest noise floor. In order to reliably operate in the higher speed modes, clean spectrum is essential.

RSSI Command and Antenna Alignment

Once the site survey is completed, you are ready to install your radios. Typically it is best to install the MU first. To properly align the radios, use the built-in RSSI tool to achieve maximum signal strength.

1. Ensure MU and RU are in Opmode "ON."
2. Connect to the RU.
3. Login and type the command ***rssi***. As you read the RSSI, move the antenna in the horizontal and vertical planes until the maximum RSSI reading is achieved
4. If it is not possible to receive an adequate RSSI reading, it may be necessary to reorient the MU (up/down, left/right), to increase the output power of the MU, or
   to move the RU to a location with better line-of-sight conditions to the MU.
5. Once you are satisfied with the RSSI reading, tighten down the RU in the optimum position.

Example:

```
#> rssi
Press any key to stop.
0> MU          -75 dB        RU    -75 dB      Connected
1> MU          -75 dB        RU    -75 dB      Connected
2> MU          -73 dB        RU    -73 dB      Connected
3> MU          -72 dB        RU    -71 dB      Connected
4> MU          -70 dB        RU    -70 dB      Connected
5> MU          -70 dB        RU    -69 dB      Connected
6> MU          -69 dB        RU    -70 dB      Connected
7> MU          -70 dB        RU    -70 dB      Connected
8> MU          -70 dB        RU    -70 dB      Connected
9> MU          -67 dB        RU    -68 dB      Connected
10> MU         -67 dB        RU    -67 dB      Connected
Success.
```

Users can also view the RSSI LEDs on the bottom of the radio. See the configuration section of this manual for more information.

Setting Maximum RF Power for Legal Operation in the U-NII Bands (-EXT only)

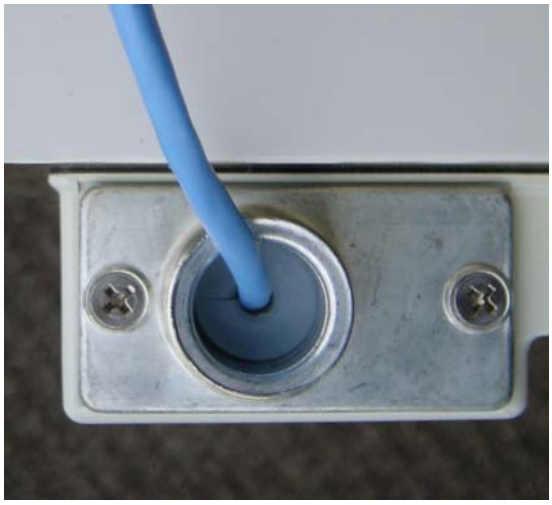
Due to FCC restrictions the professional installer must manually set the maximum power for the 5.25 to 5.35 GHz and 5.47 to 5.725 GHz U-NII bands based upon which external antenna antenna is being used.

In all cases, EIRP cannot exceed +28 dBm. Antenna Gain + Radio Max Power Setting = 28 - Antenna gain + cable loss. As an example, if the radio is being installed with a 34 dBi antenna with a 1 dB loss cable, then the radio max U-NII power must be fixed to –5 dBm. The following chart provides additional details.

Antenna Gain –cable loss	Maximum Allowed U-NII Tx Power
26	+2 dBm
30	0 dBm
33	-5 dBm

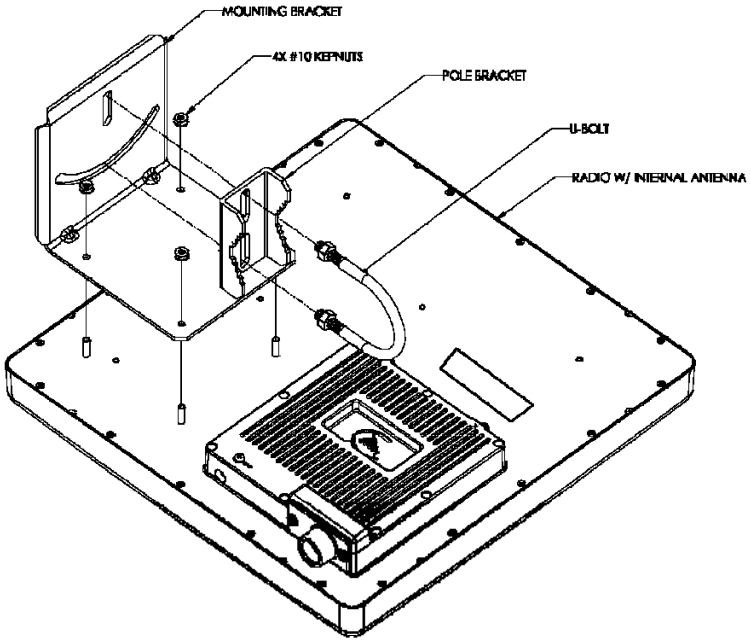
Port Plug and Port Plate (Hardware)

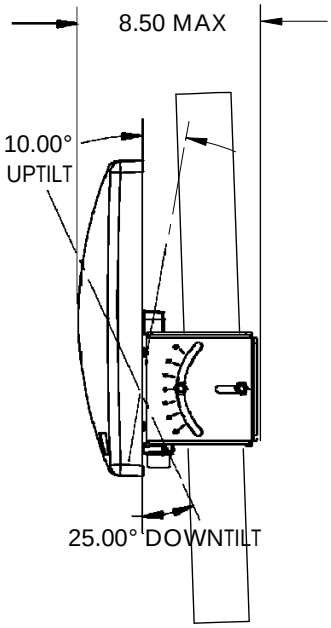
Prior to deployment, insert the silicone port plug around the Cat-5 Cable and insert into the radio's port opening. Next, screw the port plate over the silicone plug as shown in the photographs below.



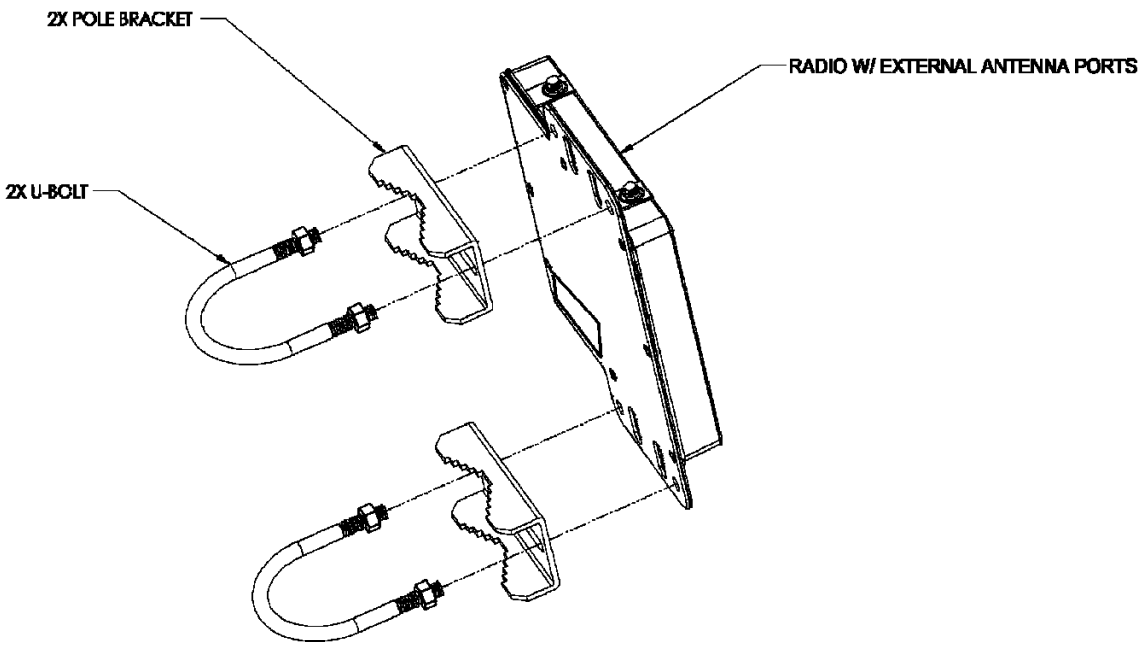
Mounting Hardware

Radios are supplied with mounting hardware for pole installations. See diagram below for proper use of the mounting hardware.





Mounting Hardware Assembly for Integrated Antenna-23-xx



Mounting Hardware Assembly for P5055M-EXT-xx

Connecting External Antenna on EXT Model

The P5055-EXT-xx is equipped with two reverse-polarity SMA connectors on the top for attachment to an external antenna. Each SMA connector is labeled with either "V" for Vertical or "H" for Horizontal polarization. Connect each cable to the appropriate "H" and "V" ports on both the antenna and the radio.

Weatherizing

It is important to properly seal each antenna connection to protect against moisture and corrosion. Each TrangoLINK-45 radio is shipped with a packet of Coax-Seal connector sealant which should be applied over each of the SMA connectors. Coax-Seal is a gum-like tape which is applied by wrapping around the connector and then compressed/molded to form a single cohesive protective covering over the connector.

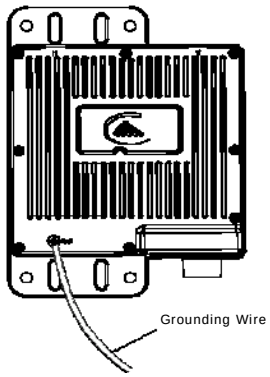
NOTE: IT IS IMPORTANT THAT THE COAXSEAL IS OVERLAPPING THE CASE TO PREVENT WATER FROM COLLECTING IN THE RECESSED AREA OF THE CONNECTOR

To properly apply the Coax-Seal product first wrap the connector/case as shown:

Secondly, compress the Coax-Seal product to mold into a single protective covering:

Grounding

Proper mounting of the radio includes consideration for grounding. Please note that if the radio is attached to a metal pole that is earth-grounded, no other grounding is necessary. If the radio is not earth-grounded via the mounting bracket, you must attach a grounding wire to the grounding stud on the radio as in the adjacent diagram.



Cat-5 Cabling Considerations

Shielded twisted pair Cat-5 cable is recommended for all installations. The shield within the Cat-5 cable does not need to be grounded if the radio itself is grounded. It is important to consider that most Cat-5 cable will deteriorate over time if exposed to the weather (especially direct sunlight). It is recommended that installers place all Cat-5 cables inside conduit. Plastic conduit is sufficient. If metal conduit is used, it is not necessary to use shielded Cat-5 cable.

Important! Please note that the silicon strain relief has a small gap when the cable is installed. This is normal.

It is important to provide strain relief and drip loop for STP Cat-5 cables. Do not mount the radio upside down as water will enter the bottom of the radio and cause permanent damage

Important! The Power-over-Ethernet injector is not a weatherized device and must be located either indoors or in a weather-protected cabinet.

Chapter 5 SNMP

SNMP

The TrangoLINK-45 supports SNMP (Simple Network Management Protocol). Network management consists of the following 3 categories: configuration, Link and Association monitoring and Alarms. Besides this proprietary Management Information Base (MIB) the TrangoLINK-45 also supports a large part of the MIB-II OIDs. These capabilities allow the system administrator to provide superior service through higher network accessibility and integrated performance monitoring.

Review the Trango MIB (TRANGO-P5M-MIB.mib) available on our website for the complete listing of all MIB objects available.

Depending on your Network Node Manager (NNM) it may be necessary to append a ".0" onto the end of each of the OIDs listed below for proper operation.

Objects for Configuration	Name	Description
1.3.6.1.4.1.5454.1.40.1.1.1	verUnitType	Returns radios unit type (0 = RU, 1= MU)
1.3.6.1.4.1.5454.1.40.1.8.3	sysswAutoScanMUSignal	Returns value of Auto Scan switch (0 = off,1 = on)
1.3.6.1.4.1.5454.1.40.1.3	sysDefaultOpmode	Returns defaultOpmode setting (0 = off,1 = on)
1.3.6.1.4.1.5454.1.40.1.4	sysCurrentOpmode	Returns current opmode setting (0 = off,1 = on)
1.3.6.1.4.1.5454.1.40.1.5	sysActivateOpmode	Turns opmode on
1.3.6.1.4.1.5454.1.40.1.13.1	sysipconfigIpAddress	Sets IP address
1.3.6.1.4.1.5454.1.40.1.13.2	sysipconfigSubnet	Sets subnet
1.3.6.1.4.1.5454.1.40.1.13.3	sysipconfigDefaultGateway	Set default gateway
1.3.6.1.4.1.5454.1.40.1.13.4	sysipconfigChange	Activates IP address change
1.3.6.1.4.1.5454.1.40.2.1	rfPeerDeviceID	Configure PeerID
1.3.6.1.4.1.5454.1.40.2.2	rfActiveChannel	Displays current channel
1.3.6.1.4.1.5454.1.40.2.3	rfActivePolarization	Displays current antenna polarization
1.3.6.1.4.1.5454.1.40.2.4	rfSpeed	Displays current Speed setting
1.3.6.1.4.1.5454.1.40.2.5	rfTxPower	Displays current transmit power (dBm)
1.3.6.1.4.1.5454.1.40.1.14	sysRemarks	Display radios remarks
Objects for Link and Association Monitoring		
1.3.6.1.4.1.5454.1.40.2.12	rfRSSI	Displays RSSI value (dBm)
1.3.6.1.4.1.5454.1.40.2.13	rfAssociated	Displays current association status (0 = disassociated,1 = associated)
1.3.6.1.4.1.5454.1.40.3.2	ruReboot	Reboots RU
1.3.6.1.4.1.5454.1.40.3.3	ruDistance	Displays current ru distance
Objects for Bandwidth Monitoring		
1.3.6.1.4.1.5454.1.40.1.9.1	systrafficEthInOctets	Displays Ethernet in (bytes)
1.3.6.1.4.1.5454.1.40.1.9.2	systrafficEthOutOctets	Displays Ethernet out (bytes)
1.3.6.1.4.1.5454.1.40.1.9.3	systrafficRfInOctets	Displays RF in (bytes)
1.3.6.1.4.1.5454.1.40.1.9.4	systrafficRfOutOctets	Displays RF out (bytes)
Objects for Alarm Monitoring		
1.3.6.1.4.1.5454.1.40.3.4.1.1	trapTrapDstEntry	
1.3.6.1.4.1.5454.1.40.3.4.1.2	trapTrapDstEnabling	Enable/Disable trap
1.3.6.1.4.1.5454.1.40.3.4.2	trapTrapIpAddress	Set destination trap IP
1.3.6.1.4.1.5454.1.40.3.4.3	trapTrapCommStr	Set trap community string

Chapter 6 Firmware Upgrade Procedure

Trango Broadband Wireless will from time to time release firmware upgrades for the TrangoLINK-45 series radios. The latest released firmware can be downloaded from http://www.trangobroadband.com/support/downloads.htm.

Firmware releases consists of two files: Main image firmware and Web (HTTP interface) firmware.

Firmware File Names

Firmware files are released in the format shown below. This example consists of main image and web firmware versions
2p0r1.

Main Image: p5055m_main_2p0r1D07061104_Pupgrade
Firmware Version: 2p0r1D07061104
File Size: 2,107,904 bytes

Web p5055m_web_1p3D07051701_Pupgrade
File Size: 143,872 bytes

Firmware Upgrade Password

The firmware filenames include the upgrade password (the characters after the '_P' in the file name) The default upgrade password in the TrangoLINK-45 radios is *upgrade*. Users may change the upgrade password within the radios using the *password upgrade* command. Firmware release files from Trango Broadband Wireless will always be names with the default upgrade password of *upgrade.* If the user changes the upgrade password in the radio, then the firmware file name must be changed as well in order to upgrade the radios.

Upgrade Procedure

1. Place firmware files in easily accessible path in your computer.
2. In order to provide the most stable wireless conditions possible during the upgrade process it is recommended to set the radio speed to the minimum (6 Mbps) in both the MU and RU. Turn autorateshifting off during the upgrade.
3. Turn on the radio's tftp daemon
4. From computer's command prompt, tftp the firmware file into the radio using binary mode.
5. After file is successfully tftp'd to the radio, the radio will automatically reboot itself and load the new firmware

IMPORTANT: DO NOT POWER CYCLE OR INTERUPT THE REBOOT PROCESS IN ANY MANNER. WAIT AT LEAST THREE MINUTES TO ENSURE AUTOMATIC REBOOT COMPLETION. LOSS OF POWER DURING THE REBOOT SEQUENCE WILL RESULT IN A CORRUPTED/INCOMPLETE FIRMWARE LOAD WHICH WILL REQUIRE REFLASHING AT THE FACTORY.

6. Repeat process for other radio
7. Repeat process for web file.

Example 1 Upgrade main image firmware to 1.0a6

FROM RADIO TELNET SESSION

```
Welcome to Trango Broadband Wireless, TrangoLINK-45 PtP-P5055M 2p0r1D07061104
Password:
Login as read/write.
#> tftpd on


Success.
#>
```

FROM COMPUTER COMMAND PROMPT SESSION

```
C:\TrangoLINK-45>dir
Volume in drive C is Local Disk
Volume Serial Number is 7802-AAF7

Directory of C:\TrangoLINK-45

  06/16/2007     08:29a        <DIR>               .
  06/16/         08:29a        <DIR>               ..
  06/11/         04:31         2,107,904           p5055m_main_2p0r1D07061104_Pupgrade
  05/17/         05:44         143,872             p5055m_web_1p3D07051701_Pupgrade
2 File(s)     2,251,776 bytes
   2 Dir(s)                  20,217,208,832 bytes free

C:\TrangoLINK-45>tftp -i 10.254.1.2 put p5m_ p5055m_main_2p0r1D07061104_Pupgrade
Transfer successful: 1868288 bytes in 9 seconds, 2107904 bytes/s

C:\TrangoLINK-45>
```

NOTE: AT THIS POINT WAIT THREE MINUTES BEFORE RECONNECTING AS RADIO REBOOTS ITSELF WITH NEW FIRMWARE

Appendix A Using the HTTP Interface

Open a browser session and type in the IP address of one of the radios. Default IP address is 192.168.100.100.

Leave the User name field blank and enter read write or read only Password. Press OK. Default password is trango. After logging on, the system information screen will be displayed.

Navigation links are shown on the left side of the browser screen. Navigable links include:

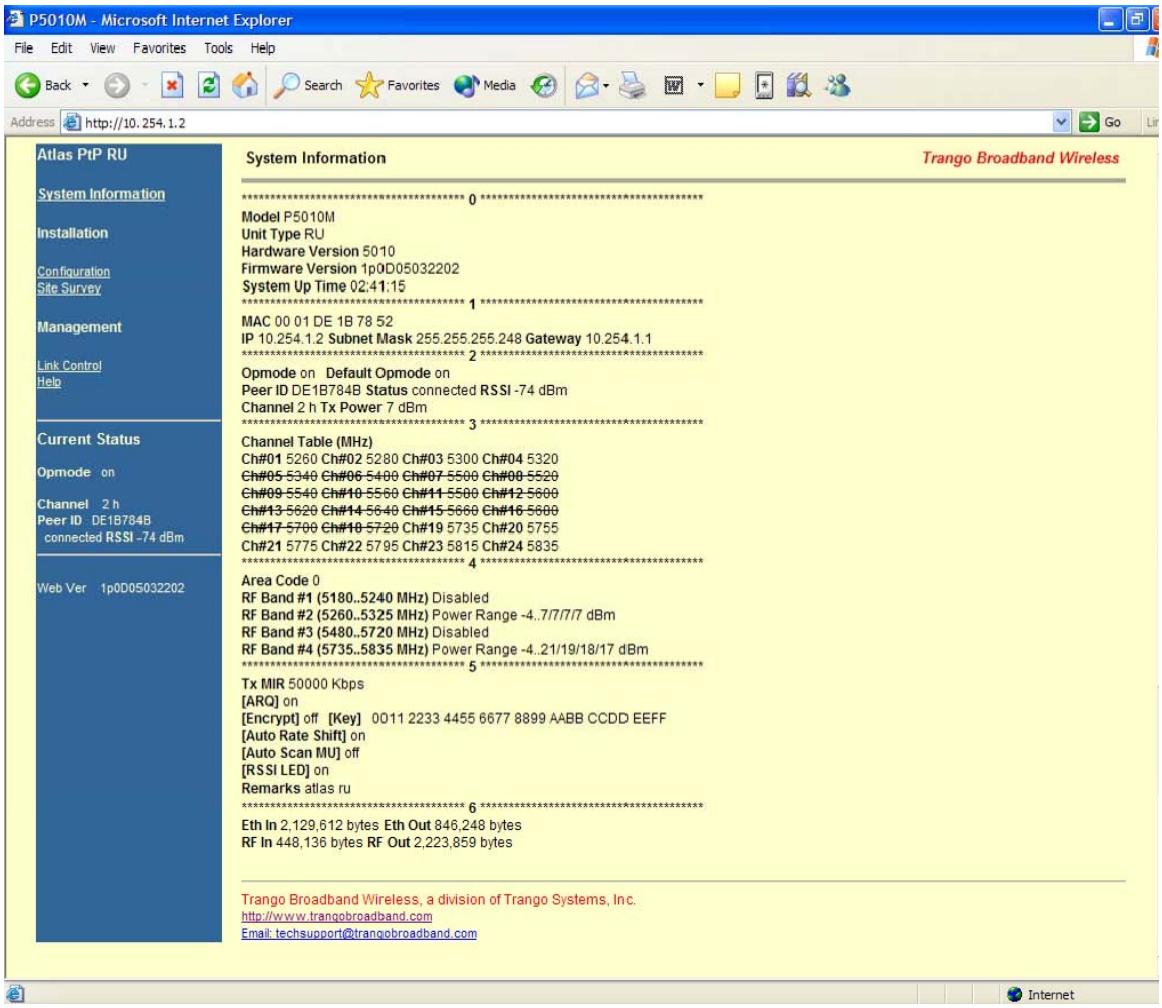
System Information
Configuration
Site Survey
Link Control
Help

The lower left portion of the screen shows the unit's current opmode, connection, channel, and antenna status. The main body of the System Information page displays most of the key parameters. To alter these parameters use the Configuration page.

To log off of the web browser interface, close the browser and the HTTP session will be automatically terminated.

System Information Page

The current radio and link status can be viewed from the System Information Page. For changes the Configuration Page should be used.


P5010M - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://10.254.1.2
Go
Atlas PtP RU
System Information
Installation
Configuration
Site Survey
Management
Link Control
Help
Current Status
Opmode on
Channel 2 h
Peer ID DE1B784B
connected RSSI -74 dBm
Web Ver 1p0D05032202
System Information
Trango Broadband Wireless
Model P5010M
Unit Type RU
Hardware Version 5010
Firmware Version 1p0D05032202
System Up Time 02:41:15
MAC 00 01 DE 1B 78 52
IP 10.254.1.2 Subnet Mask 255.255.255.248 Gateway 10.254.1.1
Opmode on Default Opmode on
Peer ID DE1B784B Status connected RSSI -74 dBm
Channel 2 h Tx Power 7 dBm
Channel Table (MHz)
Ch#01 5260 Ch#02 5280 Ch#03 5300 Ch#04 5320
Ch#05 5340 Ch#06 5480 Ch#07 5500 Ch#08 5520
Ch#09 5540 Ch#10 5560 Ch#11 5580 Ch#12 5600
Ch#13 5620 Ch#14 5640 Ch#15 5660 Ch#16 5680
Ch#17 5700 Ch#18 5720 Ch#19 5735 Ch#20 5755
Ch#21 5775 Ch#22 5795 Ch#23 5815 Ch#24 5835
Area Code 0
RF Band #1 (5180..5240 MHz) Disabled
RF Band #2 (5260..5325 MHz) Power Range -4..7/7/7/7 dBm
RF Band #3 (5480..5720 MHz) Disabled
RF Band #4 (5735..5835 MHz) Power Range -4..21/19/18/17 dBm
Tx MIR 50000 Kbps
[ARQ] on
[Encrypt] off [Key] 0011 2233 4455 6677 8899 AABB CCDD EEFF
[Auto Rate Shift] on
[Auto Scan MU] off
[RSSI LED] on
Remarks atlas ru
Eth In 2,129,612 bytes Eth Out 846,248 bytes
RF In 448,136 bytes RF Out 2,223,859 bytes
Trango Broadband Wireless, a division of Trango Systems, Inc.
http://www.trangobroadband.com
Email: techsupport@trangobroadband.com
Internet

Model: Model number.

Unit Type: P5055M unit type either MU (master) or RU (remote).

Hardware Version: Hardware version is factory-set and cannot be changed by user.

Firmware Version: Current firmware version loaded in the radio.

System Up Time: Time since radio was last rebooted or powered.

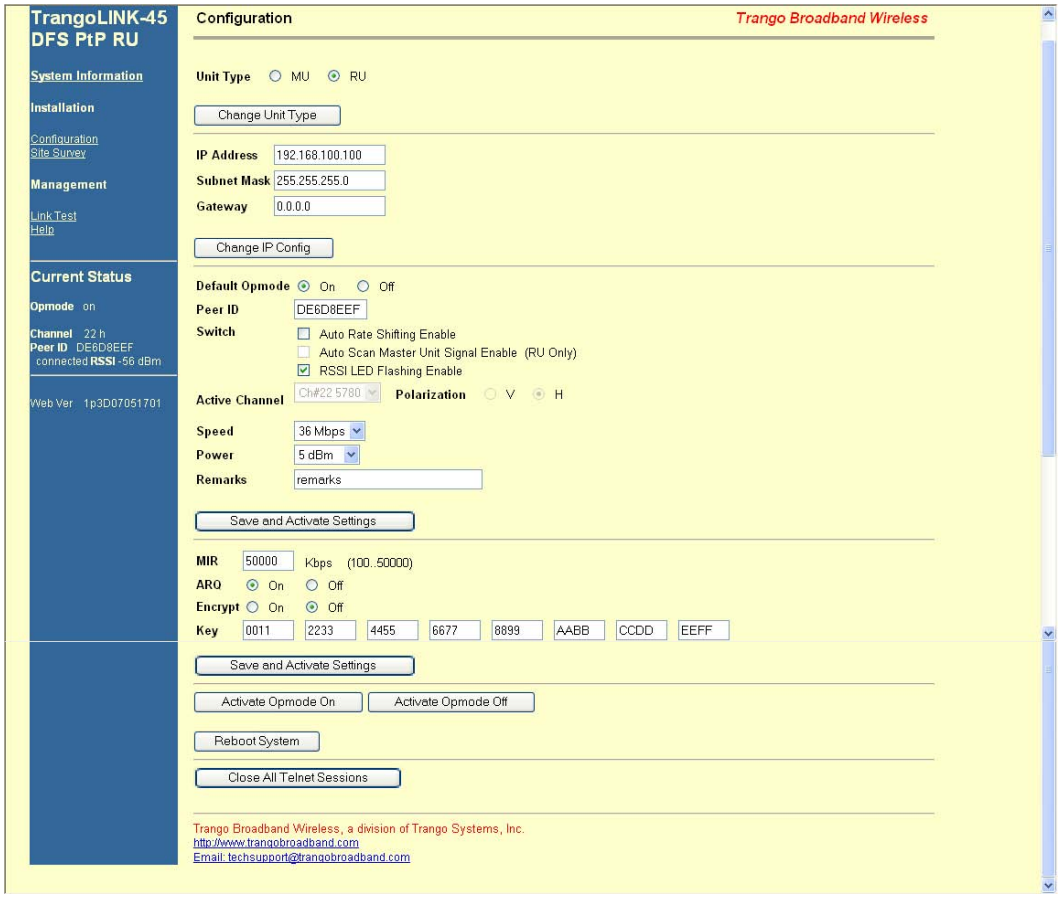
MAC: MAC address of the radio.

IP, Subnet Mask, Gateway: IP, subnet mask, and gateway of radio

Opmode:	Current operation of the radio.\"On\" indicates transmitting. \"Off\" indicates not transmitting.
Default Opmode:	Opmode which radio enters after reboot or power cycle.
Peer ID:	User entered MAC address of the peer unit. In the MU, Peer ID is the MAC address of the RU. In the RU, Peer ID is the MAC address of the MU.
Status:	Status of Remote Unit. Connected (wireless link established) or disconnected (wireless link not established).
RSSI:	Relative Signal Strength Indicator. Displays signal strength received from the Remote Unit. 'n/a' indicates Remote Unit is not connected.
Tx MIR:	Transmit Maximum Information Rate to the peer unit. **Channel:** RF Channel
Tx Power:	Transmit power
Channel Table:	Set of channels based on the area code setting. Channels which are lined- out are not available for use based on area code setting.
Area Code:	Country code – defines set of available channels and maximum power based on regulatory restrictions. Setting cannot be changed by user.
Auto Rate Shift:	See definition in Configuration section .
Auto Scan MU:	See definition in Configuration section.
RSSI LED:	See definition in Configuration section.
Remarks:	See definition in Configuration section.
Eth In:	Counter for Ethernet packets which entered via the Ethernet port of the radio.
Eth Out:	Counter for Ethernet packets which exited via the Ethernet port of the radio.
RF In:	Counter for Ethernet packets which entered over-the-air into the radio.
RF Out:	Counter for Ethernet packets which exited over-the-air out the radio.

Configuration Page

All user configurable parameters can be entered from the Configuration Page and this is the only page used to provision a wireless link between the two radios.



IP Address: The IP address of this radio; used to manage the radio's application layer.

Subnet Mask: The subnet mask of the radio.

Gateway: The default gateway of the radio.

Default Opmode: Operation mode of the radio after power cycle. When Opmode is \"On\" the radio will attempt to make a wireless connection. When Opmode is \"Off\" the radio is not transmitting, but can be managed from the wired side. In addition to setting Default Opmode to \"Off\", Opmode can be set to \"Off\" by interrupting the radios boot-up cycle in the first 30 seconds after power up

Peer ID: User entered MAC address of the partner unit.

Check Boxes: Checked means active

Auto Rate Shifting — When enabled, radio will automatically shift TX rate up or down depending on link quality.

Autoscan MU	(RU Only). If this switch is enabled, when not connected to MU, the RU will automatically automatically scan all available channels and frequencies
RSSI LED	Enables and disables RSSI LEDs. Disabling the LEDs provides slight improvement to radio performance. Typically RSSI LEDs should be enabled during alignment and disabled during normal operation.
Active Channel/Polarization:	The current channel and polarization of the radio when Opmode is \"On\".
Speed:	Transmit over-the-air raw data rate.
Power:	Transmit RF power setting.
Range:	Allowable range of the transmit power based on the current settings of the active channel and the speed.
Remarks:	A descriptive text field for general use (i.e. the location of the unit). It does not affect system performance.
MIR:	Set Maximum Information Rate for network traffic.
ARQ: .	Auto Retransmit Request. When enabled, dropped packets are detected at the receiver and retransmitted by the transmitter.
Encrypt: .	Encryption. Enables and disables proprietary 128 bit over-the-air encryption.
Key: .	128 Encryption Key. Must match in both MU and RU.
Activate Opmode On:	Activates radio's Opmode to "On"-transmitting.
Activate Opmode Off:	Activates radio's Opmode to "Off" not-transmitting.
Reboot:	Reboot the unit.
Close All Telnet Sessions:	Close all the active telnet sessions.

Configuration Screen – Minimum Required Settings to Establish a Wireless Link

To configure a wireless link, user must (at a minimum) enter the following information:

Unit Type: Set one radio as the MU and one radio as the RU. Click on "Change Unit Type" to save the setting.

IP Configuration: Each radio should be set up with a unique IP address to enable remote management. Click on "Change IP Config" to save the setting.

Default Opmode: Should be "On". Radio will enter default opmode approximately 30 seconds after complete reboot cycle. Opmode must be "On" for radios to transmit and wirelessly connect.

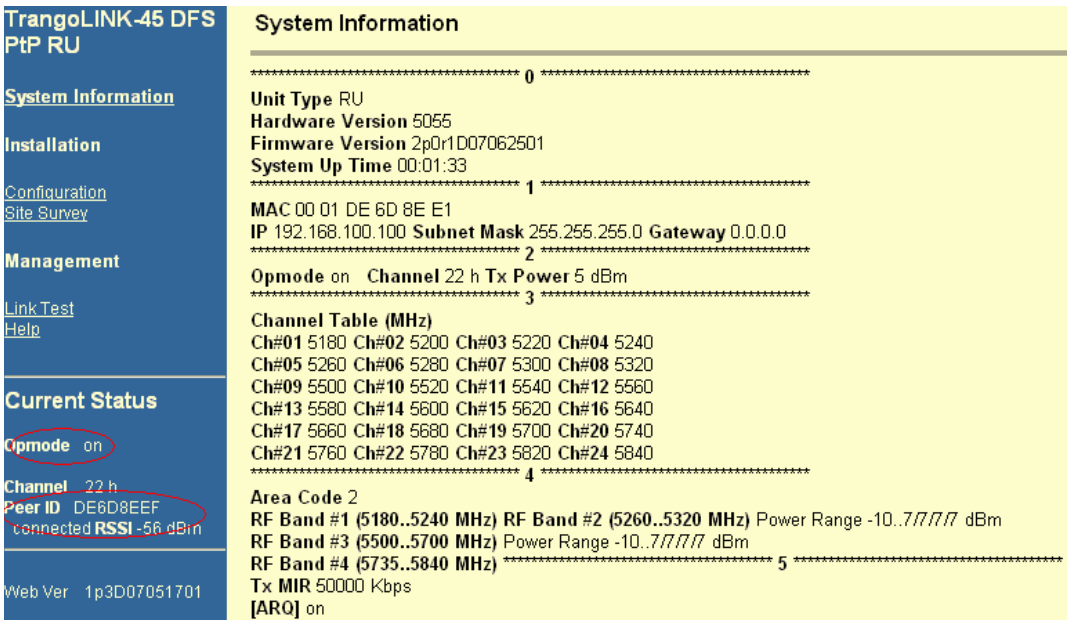
Peer ID: Enter the last 8 digits of the peer units MAC address. P5055M radios will only wirelessly connect to the peer ID with the specified MAC address.

Active Channel: Select a channel & antenna polarization. Both MU and RU should be set to the same channel unless RU's "Auto Scan Master Unit Signal Enable" is enabled. If Auto Scan is enabled, the RU will automatically scan all channels and polarizations searching for it's peer MU. Once the MU is detected, the RU will automatically set its active channel and antenna polarization to that of the MU.

Click "Save and Activate Settings" to save settings.

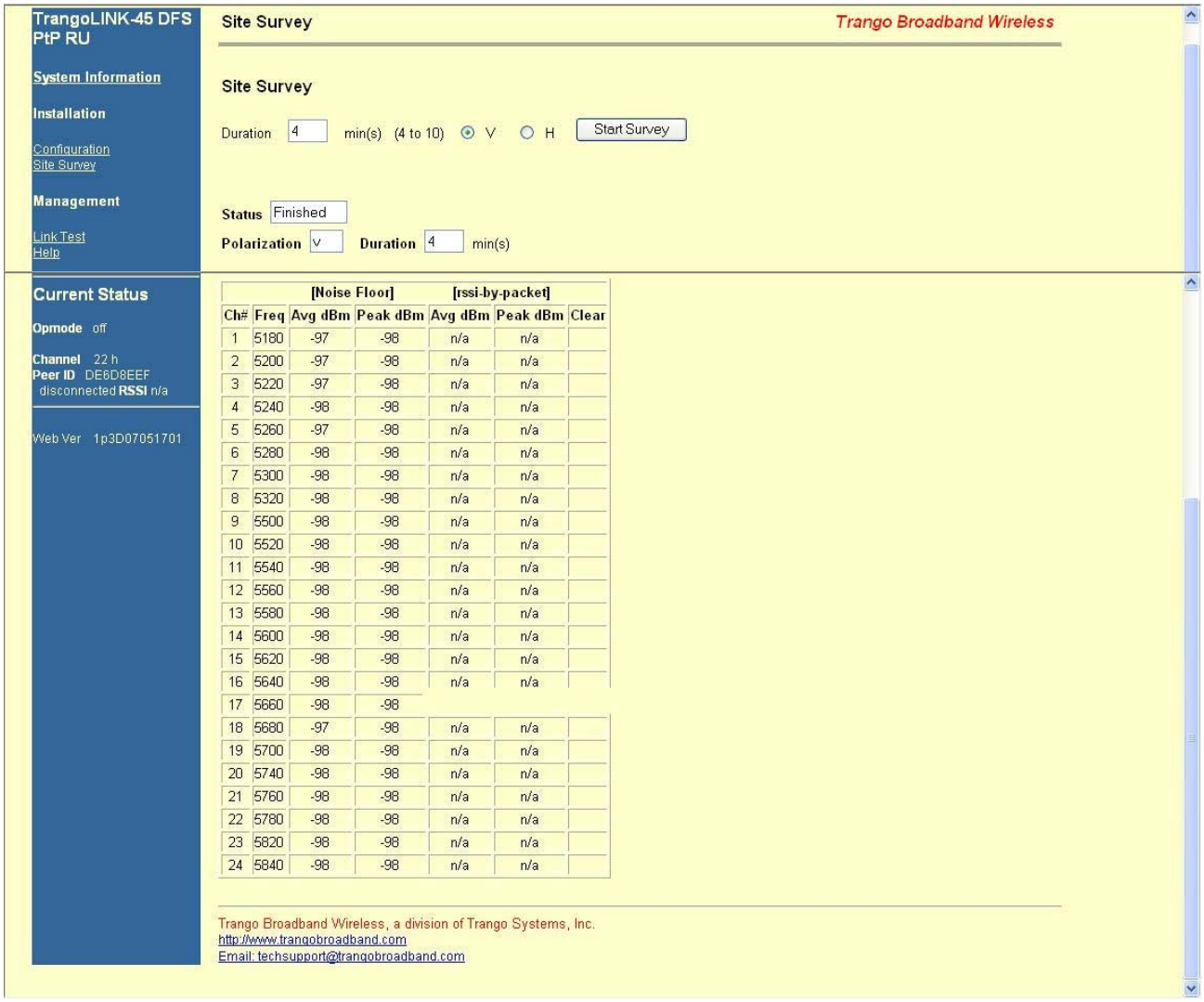
If all settings are entered correctly, and if radios are within operating range – the MU and RU will automatically wirelessly connect and Ethernet traffic will begin to pass across the wireless link.

To verify connection status, refer to the System Information page. The status can be viewed in the left-hand margin portion of all HTTP screens. Signal strength (RSSI) received from the peer radio is also provided on this screen.


TrangoLINK-45 DFS PtP RU
System Information
Installation
Configuration
Site Survey
Management
Link Test
Help
Current Status
Opmode on
Channel 22 h
Peer ID DE6D8EEF
connected RSSI -56 dBm
Web Ver 1p3D07051701
System Information
********** 0 **********
Unit Type RU
Hardware Version 5055
Firmware Version 2p0r1D07062501
System Up Time 00:01:33
********** 1 **********
MAC 00 01 DE 6D 8E E1
IP 192.168.100.100 Subnet Mask 255.255.255.0 Gateway 0.0.0.0
********** 2 **********
Opmode on Channel 22 h Tx Power 5 dBm
********** 3 **********
Channel Table (MHz)
Ch#01 5180 Ch#02 5200 Ch#03 5220 Ch#04 5240
Ch#05 5260 Ch#06 5280 Ch#07 5300 Ch#08 5320
Ch#09 5500 Ch#10 5520 Ch#11 5540 Ch#12 5560
Ch#13 5580 Ch#14 5600 Ch#15 5620 Ch#16 5640
Ch#17 5660 Ch#18 5680 Ch#19 5700 Ch#20 5740
Ch#21 5760 Ch#22 5780 Ch#23 5820 Ch#24 5840
********** 4 **********
Area Code 2
RF Band #1 (5180..5240 MHz) RF Band #2 (5260..5320 MHz) Power Range -10..7///// dBm
RF Band #3 (5500..5700 MHz) Power Range -10..7///// dBm
RF Band #4 (5735..5840 MHz) ********** 5 **********
Tx MIR 50000 Kbps
[ARQ] on

Site Survey Page

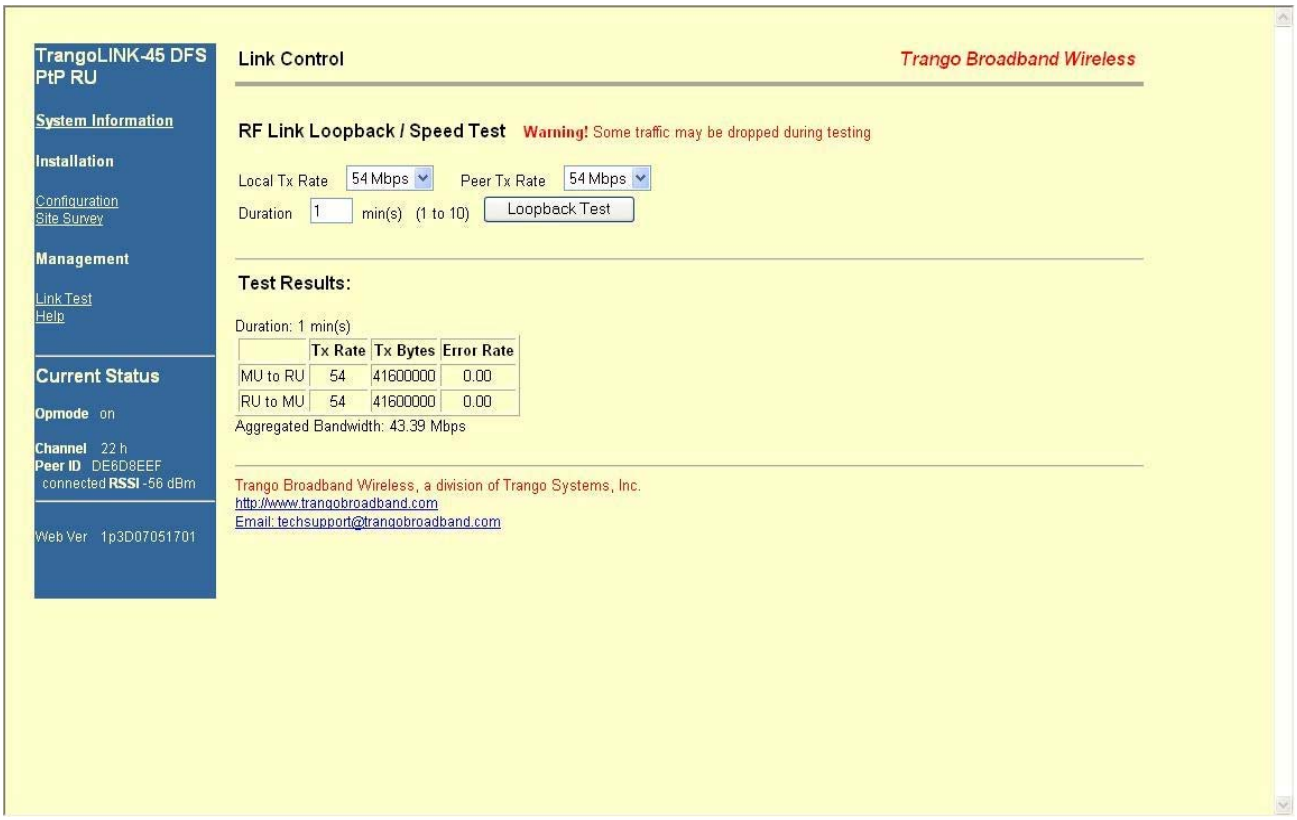
The site survey function measures overall noise floor as well as in-band noise containing data packets. Noise is reported in terms of average and peak dBm for the period tested. The user specifies duration of the test in minutes as well as the antenna port. To run a site survey, the radio must be in Opmode OFF.


TrangoLINK-45 DFS PtP RU
System Information
Installation
Configuration
Site Survey
Management
Link Test
Help
Site Survey
Trango Broadband Wireless
Site Survey
Duration 4 min(s) (4 to 10) V H Start Survey
Status Finished
Polarization V Duration 4 min(s)
Current Status
Opmode off
Channel 22 h
Peer ID DE6D8EEF
disconnected RSSI n/a
Web Ver 1p3D07051701
[Noise Floor] [rssi-by-packet]
Ch# Freq Avg dBm Peak dBm Avg dBm Peak dBm Clear
1 5180 -97 -98 n/a n/a
2 5200 -97 -98 n/a n/a
3 5220 -97 -98 n/a n/a
4 5240 -98 -98 n/a n/a
5 5260 -97 -98 n/a n/a
6 5280 -98 -98 n/a n/a
7 5300 -98 -98 n/a n/a
8 5320 -98 -98 n/a n/a
9 5500 -98 -98 n/a n/a
10 5520 -98 -98 n/a n/a
11 5540 -98 -98 n/a n/a
12 5560 -98 -98 n/a n/a
13 5580 -98 -98 n/a n/a
14 5600 -98 -98 n/a n/a
15 5620 -98 -98 n/a n/a
16 5640 -98 -98 n/a n/a
17 5660 -98 -98
18 5680 -97 -98 n/a n/a
19 5700 -98 -98 n/a n/a
20 5740 -98 -98 n/a n/a
21 5760 -98 -98 n/a n/a
22 5780 -98 -98 n/a n/a
23 5820 -98 -98 n/a n/a
24 5840 -98 -98 n/a n/a
Trango Broadband Wireless, a division of Trango Systems, Inc.
http://www.trangobroadband.com
Email: techsupport@trangobroadband.com

Link Control

The Link Control page features the RF Link Loopback / Speed Test. In this test, the user specifies the transmission rate (in Mbps) in both the local radio and the peer radio as well as the duration time (in minutes) for the test. During the test, the local radio will transmit packets across the wireless link. The peer radio will retransmit equivalent packets back to the local radio. The test will measure and report error rate and actual throughput as measured in Mbps. The following link test was run for 60 seconds with a specified TX rate of 54 Mbps per end.

To run a link loopback test, both radios must be in Opmode ON and status "Connected"



In this example, the error rate was 0 packets from MU to RU and 0 packets from RU to MU. Measured aggregate bandwidth is 43.39 Mbps.

Appendix B Specifications

RF Parameters

RF Conducted Power and Receiver sensitivity for $1x10^{-3}$ Frame error rate with ARQ active:

- US / IC MODELS*

Speed Setting (over-the-air rate) (Mbps)	Modulation Scheme	Receiver Sensitivity (dB)	Max Power 5.18 to 5.24 GHz (dBm)	Max Power 5.265- 5.325, 5.5 to 5.7 GHz (DFS-UNII) (dBm)	Max Power 5.735 to 5.84 GHz (ISM) (dBm)
6(5)	BPSK	-92	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+21
12(11)	QPSK	-87	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+19
18(16)	QPSK	-85	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+19
24(20)	16QAM	-84	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+18
36(31)	16QAM	-80	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+18
48(40)	64QAM	-75	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+17
54(45)	64QAM	-73	NA	+2 (-EXT) ,+6 (-23), +10(-19)	+17

*Note IC models excludes 5.600-5.650GHz frequency range.

- EU MODELS

Speed Setting (over-the-air rate) (Mbps)	Modulation Scheme	Receiver Sensitivity (dB)	Max Power 5.18 to 5.24 GHz (ETSI) (dBm)	Max Power 5.26- 5.32, 5.5 to 5.7 GHz (ETSI) (dBm)	Max Power 5.725 to 5.85 GHz (dBm)
6(5)	BPSK	-92	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
12(11)	QPSK	-87	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
18(16)	QPSK	-85	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
24(20)	16QAM	-84	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
36(31)	16QAM	-80	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
48(40)	64QAM	-75	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA
54(45)	64QAM	-73	NA (-EXT) ,+0 (-23), +4(-19)	+3 (-EXT) ,+7 (-23), +11(-19)	NA

- OE MODELS

Speed Setting (Max Tput) (Mbps)	Modulation Scheme	Receiver Sensitivity (dB)	Max Power 5.18 to 5.24 GHz (ETSI) (dBm)	Max Power 5.26- 5.32, 5.5 to 5.7 GHz (ETSI) (dBm)	Max Power 5.725 to 5.85 GHz (dBm)
6(5)	BPSK	-92	+14	+14	+21
12(11)	QPSK	-87	+13	+13	+19
18(16)	QPSK	-85	+13	+13	+19
24(20)	16QAM	-84	+12	+12	+18
36(31)	16QAM	-80	+12	+12	+18
48(40)	64QAM	-75	+11	+11	+17
54(45)	64QAM	-73	+11	+11	+17

NOTE: Numbers in parentheses are actual max user aggregate throughput speeds

RF Data Rate: 6, 12, 18, 24, 36, 48, 54 MBPS User selectable
Error Correction: FEC & ARQ
Modulation: 6 MBPS DBPSK OFDM for header, 6-54 MBPS OFDM for payload

Channels of Operation

Storable Channels: 24 memory locations

Center frequency ranges:

(-US models)
Band 1: NA
Band 2: 5.265 to 5.325 GHz (DFS)
Band 3: 5.500 to 5.700 GHz (DFS)
Band 4: 5.735 to 5.840 GHz

(-IC models)
Band 1: NA
Band 2: 5.265 to 5.325 GHz (DFS)
Band 3: 5.500 to 5.700 GHz (DFS) excluding 5.600-5.650GHz
Band 4: 5.735 to 5.840 GHz

(-EU models)
Band 1: 5.180 to 5.240 GHz
Band 2: 5.260 to 5.320 GHz (DFS)
Band 3: 5.500 to 5.700 GHz (DFS)
Band 4: NA

(-OE models)
Band 1: 5.180 to 5.240 GHz
Band 2: 5.260 to 5.320 GHz (DFS)
Band 3: 5.500 to 5.700 GHz (DFS)
Band 4: 5.735 to 5.840 GHz

Tuning resolution: 5 MHz increments

Default Channel assignments:

(-US Models)

Channel 1: 5.265 GHz
Channel 2: 5.285 GHz
Channel 3: 5.305 GHz
Channel 4: 5.325 GHz
Channel 5: 5.500 GHz
Channel 6: 5.520 GHz
Channel 7: 5.540 GHz
Channel 8: 5.560 GHz
Channel 9: 5.580 GHz
Channel 10: 5.600 GHz
Channel 11: 5.620 GHz
Channel 12: 5.640 GHz
Channel 13: 5.660 GHz
Channel 14: 5.680 GHz
Channel 15: 5.700 GHz
Channel 16: 5.735 GHz
Channel 17: 5.755 GHz
Channel 18: 5.775 GHz
Channel 19: 5.795 GHz
Channel 20: 5.815 GHz
Channel 21: 5.835 GHz
Channel 22: 5.840 GHz
Channel 23: 5.840 GHz
Channel 24: 5.840 GHz

(-IC Models)

Channel 1: 5.265 GHz
Channel 2: 5.285 GHz
Channel 3: 5.305 GHz
Channel 4: 5.325 GHz
Channel 5: 5.500 GHz
Channel 6: 5.520 GHz
Channel 7: 5.540 GHz
Channel 8: 5.560 GHz
Channel 9: 5.580 GHz
Channel 10: Disabled
Channel 11: Disabled
Channel 12: Disabled
Channel 13: 5.660 GHz
Channel 14: 5.680 GHz
Channel 15: 5.700 GHz
Channel 16: 5.735 GHz
Channel 17: 5.755 GHz
Channel 18: 5.775 GHz
Channel 19: 5.795 GHz
Channel 20: 5.815 GHz

Channel 21: 5.835 GHz
Channel 22: 5.840 GHz
Channel 23: 5.840 GHz
Channel 24: 5.840 GHz

(-EU Models)

Channel 1: 5.180 GHz
Channel 2: 5.200 GHz
Channel 3: 5.220 GHz
Channel 4: 5.240 GHz
Channel 5: 5.260 GHz
Channel 6: 5.280 GHz
Channel 7: 5.300 GHz
Channel 8: 5.320 GHz
Channel 9: 5.500 GHz
Channel 10: 5.520 GHz
Channel 11: 5.540 GHz
Channel 12: 5.560 GHz
Channel 13: 5.580 GHz
Channel 14: 5.600 GHz
Channel 15: 5.620 GHz
Channel 16: 5.640 GHz
Channel 17: 5.660 GHz
Channel 18: 5.680 GHz
Channel 19: 5.700 GHz
Channel 20: Disabled
Channel 21: Disabled
Channel 22: Disabled
Channel 23: Disabled
Channel 24: Disabled

(-OE Models)

Channel 1: 5.180 GHz
Channel 2: 5.200 GHz
Channel 3: 5.220 GHz
Channel 4: 5.240 GHz
Channel 5: 5.260 GHz
Channel 6: 5.280 GHz
Channel 7: 5.300 GHz
Channel 8: 5.320 GHz
Channel 9: 5.500 GHz
Channel 10: 5.520 GHz
Channel 11: 5.540 GHz
Channel 12: 5.560 GHz
Channel 13: 5.580 GHz
Channel 14: 5.600 GHz
Channel 15: 5.620 GHz
Channel 16: 5.640 GHz
Channel 17: 5.660 GHz
Channel 18: 5.680 GHz

Channel 19: 5.700 GHz
Channel 20: 5.740 GHz
Channel 21: 5.760 GHz
Channel 22: 5.780GHz
Channel 23: 5.820 GHz
Channel 24: 5.840 GHz

Data Parameters

Format:	10/100 BaseT IEEE 802.3 Ethernet compliant Ethernet packet: Up to 1518 byte packets

Regulatory Compliance

FCC Standards
FCC 15.109
FCC 15.203 Antenna
FCC 15.207
FCC 15.209
FCC 15.401 through 15.407(2) U-NII Band transmitter –
FCC 15.247 ISM transmitter

ETSI

EN 301-489-17	EMC
EN 301 893	Radio Compliance
EN 60950	Safety
EN 50385	

Canada Standards
RSS-210
RSS-102
ICES-003

Mechanical

Material:	Powdercoated Aluminum case/back with UV Stabilized ABS radome (P5055-19,-23)
Size:	8.5" x 7.75" for P5055M-19-xx 15” x 15” for P5055M-23-xx 5” X 5” for P5055M-EXT –xx
Weight:	P5055M-19-xx: 4 lb P5055M-23-xx: 7 lb P5055M-EXT-xx: 4 lb
Mounting:	Custom pole/flat surface mounting with elevation adjustment.

Environmental

Operating Temp:	-40 to 60 deg
C Storage:	-40 to 85 deg
C	
Humidity:	100 % when sealed properly
NEMA Rating:	NEMA 4
Shock:	Sustain 3 axis drop from 5 feet

Power Parameters

Input Voltage:	Input voltage range at unit is 15 VDC to 24 VDC max. Power is supplied on Ethernet cable using junction box provided with up to 330 foot 24 AWG STP cable.
Current Cons.:	Max 600 mA in transmit and receive modes using 24 V standard adapter (12 W) with short Ethernet cable from Junction box to radio.

Power Supply

Type:	Switch mode wall mount transformer
Safety:	PSE, UL, CUL, GS
EMI:	FCC Class B, VCC-II, CE
Input:	90 – 255 VAC
Plug Type:	Includes 4 plug blades for to allow use in US, Europe, UK and Australia
Output:	24 VDC +/- 1 V
Max current:	1000 mA

Antennas

Integrated 19 dBi Antenna (for P5055M-19-xx)

Frequency range:	4950-5850 MHz
Gain:	19 dBi +/- 1 dB
Front/Back Ratio	>30 dB
E-Plane Beamwidth:	> 18 degrees typical H-
Plane Beamwidth:	> 18 degrees typical
Polarization:	Vertical and Horizontal
Port/Port Isolation:	20 dB typ
Cross Pol Rejection:	20 dB typ
VSWR:	<1.7:1
Package:	Alumininum backplate with plastic radome.
Dimensions:	8.5" x 7.75" x 1.25" (216mm x 197mm x 32mm)
Weight:	2 lbs (.91Kg)
Mounting Provisions:	Mounting kit supplied for up to 3”diam pole or flat surface
Azimuth/El Adjust:	+/-30 degrees
Sealing:	Water tight to 1 meter IEC 529/IP67
Temp Range:	-40 deg F to +160 deg F (-40 deg C to +60 deg C)
Wind speed operational:	100 mph (160 km/hr)
Wind speed survival:	140 mph (220 km/hr)

Integrated 23 dBi Antenna (for P5055M-23-xx)

Frequency range:	4950-5850 MHz
Gain:	23 dBi +/- 1 dB
Front/Back Ratio	>35 dB
E-Plane Beamwidth:	> 9 degrees typical H-
Plane Beamwidth:	> 9 degrees typical
Polarization:	Vertical and Horizontal
Port/Port Isolation:	40 dB typ
Cross Pol Rejection:	25 dB typ
VSWR:	<1.7:1
Package:	Alumininum backplate with plastic radome.
Dimensions:	14.6”x 14.6”x 1.58” (371mm x 371mm x 40mm)
Weight:	5.5 lbs (2.5 kg)
Mounting Provisions:	Mounting kit supplied for up to 3”diam pole or flat surface
Azimuth/El Adjust:	+/-30 degrees
Sealing:	Water tight to 1 meter IEC 529/IP67
Temp Range:	-40 deg F to +160 deg F (-40 deg C to +60 deg C)
Wind speed operational:	100 mph (160 km/hr)
Wind speed survival :	140 mph (220 km/hr)

FCC Certified External Antennas (for P5055M-EXT-xx)

Radiowaves models:	SPD4-5.2, SPD3-5.2, SPD2-5.2, SPD1-5.2

See Radiowaves, Inc. for specifications and details